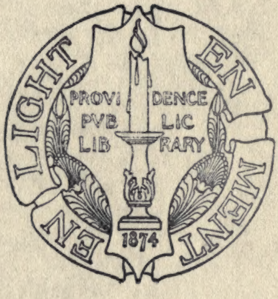

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FARMERS' BULLETINS
Nos. 1226–1250

WITH CONTENTS AND INDEX

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FARMERS' BULLETIN 1226

TAKE-ALL OF WHEAT
AND ITS CONTROL

UNITED STATES DEPARTMENT OF AGRICULTURE

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1921

TAKE-ALL OF WHEAT was first discovered in this country in April, 1919, near Granite City, Madison County, Ill. It was found later in Sangamon and Mason Counties in the same State and in Laporte, Porter, and Tippecanoe Counties in Indiana.

Under conditions favorable to the disease, take-all may ruin an affected field of wheat. Usually, however, it occurs in irregular, scattered spots of different sizes. In most of the diseased fields the yields have been reduced less than 20 per cent.

Take-all is recognized in the field by dwarfed or stunted, "bunchy," dying plants in the spots mentioned.

All diseased plants tiller more than usual, which makes them look "bunchy." At first they are dull bluish in color, but later they turn brown and finally die. In the later stages of the disease, plants show more or less rotting of the roots and a brown rot of the stems underground.

If conditions are favorable for wheat, some of the diseased plants may partly recover and produce a small yield of grain, most of which is usually shrunken. Such plants mature later than the healthy ones.

Take-all may be controlled by sowing varieties of wheat known to be resistant to the disease.

Only a few varieties have been tested. Red Wave, Early May, and Turkey practically are immune from take-all, and Fultz and Fulcaster are very resistant. The so-called Salzer Prizetaker and the Red Cross, as grown in that part of Illinois in which this disease has been found, are so susceptible as to be worthless.

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief
Washington, D. C. August, 1921

TAKE-ALL OF WHEAT AND ITS CONTROL.[1]

HARRY B. HUMPHREY, *Pathologist in Charge,* AARON G. JOHNSON, *Pathologist,* and HAROLD H. MCKINNEY, *Assistant Pathologist, Cereal-Disease Investigations, Office of Cereal Investigations.*

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DISCOVERY OF TAKE-ALL IN THE UNITED STATES.

The presence of take-all on winter wheat was discovered about the middle of April, 1919, through a report from the county agent of Madison County, Ill., that wheat near Granite City was being severely injured by some disease. Later this disease was found in other parts of Illinois and in Indiana.

Shortly after the discovery of this trouble the name "take-all" was applied to it tentatively on account of certain characteristics which it possessed in common with the Australian take-all of wheat. More extensive field and laboratory investigations indicate that it is different from the Australian disease, as it is generally understood to occur in Australia. However, until the cause of the type of disease occurring in Illinois and Indiana has been determined, the tentative use of the name "take-all" is continued.

ECONOMIC IMPORTANCE.

Under conditions favorable for its development, take-all may cause considerable damage. In the spring of 1919 some of the fields in Madison County, Ill., were so badly affected that they were plowed up and planted to other crops. In one case a 40 per cent actual reduction was caused in the total yield of grain in a 50-acre field in that county. In most cases observed, however, the actual reduction in yield has been less than 20 per cent.

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[1] All the field experiments for the control of take-all have been conducted on fields in the "American bottoms" of the Mississippi River near Granite City, Ill., in cooperation with the Illinois Agricultural Experiment Station. Certain laboratory and greenhouse studies have been conducted in cooperation with the department of plant pathology at the Wisconsin Agricultural Experiment Station. In 1919 the field-laboratory studies were conducted in the laboratories of the Missouri Botanical Garden, St. Louis, Mo., through the kindness of Director George T. Moore and Dr. B. M. Duggar. In 1920, through the courtesy of Superintendent L. P. Frohardt, the field-laboratory studies were made in the laboratories of the Granite City, Ill., High School.

Under conditions favorable for the wheat crop, the diseased plants recover to a considerable extent and produce some grain. Usually the disease so delays their growth that they do not mature until some time later than healthy plants and so contain only shrunken grain at harvest time. To reduce the losses of grain in badly infested fields it is necessary to postpone the harvest date until the bulk of the crop is ripe. Frequently it is more economical to suffer a small loss due to the shattering of the overripe, healthy grain than to lose the late-maturing grain in the infested patches. In cases where there is a large diseased area in a field it is best to harvest it separately later, thus reducing the losses to the minimum.

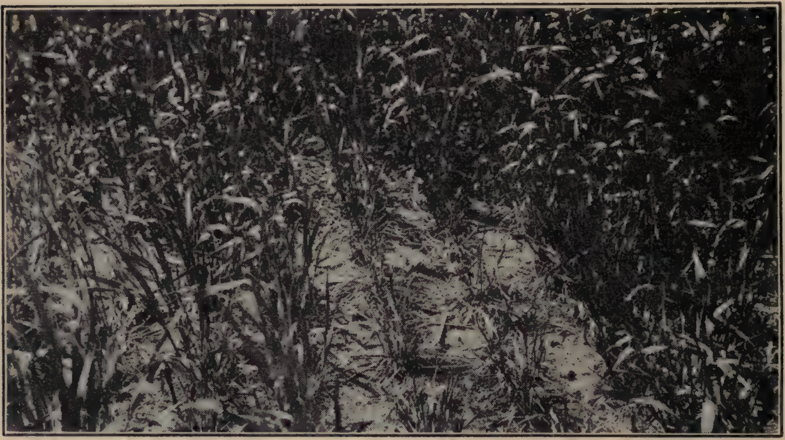

FIG. 1.—Portion of a spot in a wheat field infested with take-all.

GEOGRAPHIC DISTRIBUTION.

So far as known this particular disease occurs only in the States of Illinois and Indiana. There is a possibility that it may be present in Colorado, but this has not been determined with certainty.

Similar troubles have appeared in Virginia, Kansas, and Washington, but investigations indicate that these have had a different cause. One small outbreak of the true Australian take-all apparently has occurred in New York, another in Arkansas, and a third in Oregon.

CROPS AFFECTED.

Investigations conducted thus far have not shown positively that any other crop but wheat is susceptible to the disease. There are some indications that rye may be very slightly susceptible.

SYMPTOMS.

SYMPTOMS IN THE SPRING.

The conspicuous symptoms of the disease first become evident in the spring after growth of the healthy plants is well started. Distinct patches of badly dwarfed plants show up here and there in some fields without regard to the type or condition of the soil (fig. 1). Some of these patches may be so small as to include only a comparatively few diseased plants; sometimes, in fact, the diseased plants may occur one in a place, here and there, intermixed with apparently healthy plants. In such cases these diseased plants are difficult to find, and hence are commonly overlooked. Definite spots containing diseased plants usually can be recognized. The edge of such a spot generally is more sharply defined than the margins of spots caused by unfavorable soil conditions, especially poor drainage. In such spots most of the plants are diseased, and therefore stunted right up to the edge of the spot (fig. 2, *B*). In spots caused by local unfavorable soil conditions all the plants usually decrease in height rather gradually from the edge toward the center (fig. 2, *A*).

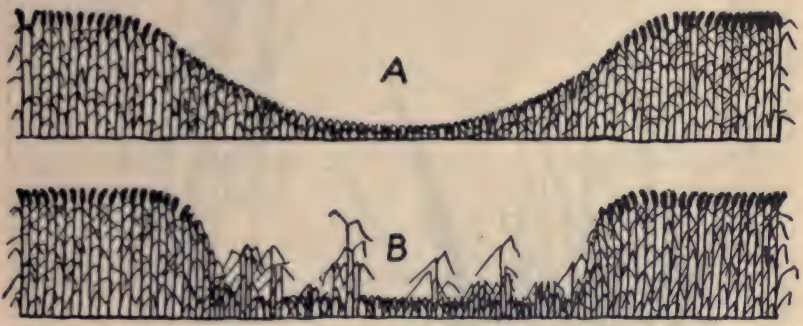

FIG. 2.—Diagram of a section of a spot caused by local abnormal soil conditions (*A*) and a spot caused by take-all (*B*).

In fields more severely infested, the patches may be very large and contain a high percentage of diseased plants, or even cover large portions of the infested fields.

Wherever found, the diseased plants show certain distinct characteristics, particularly (1) dwarfing, and a little later (2) abnormal dark-green coloration of the fall leaves, (3) dying of outer leaves and fall tillers and basal browning, (4) excessive development of spring tillers, or (5) some plants may be killed entirely.

Early in the spring, if healthy and diseased plants growing side by side are pulled up, it will be noted that the disease is fairly well limited to individual plants which at that time show marked dwarfing but no basal browning of the living tissues. A little later the diseased plants show a browning, and still later a rotting of the basal portions, that is, those parts just below the surface of the ground. The roots may not show any particular evidence of disease or they may show some discoloration when the basal browning occurs. The diseased plants may be immediately adjacent to and intermixed with healthy plants. Along with the development of the basal

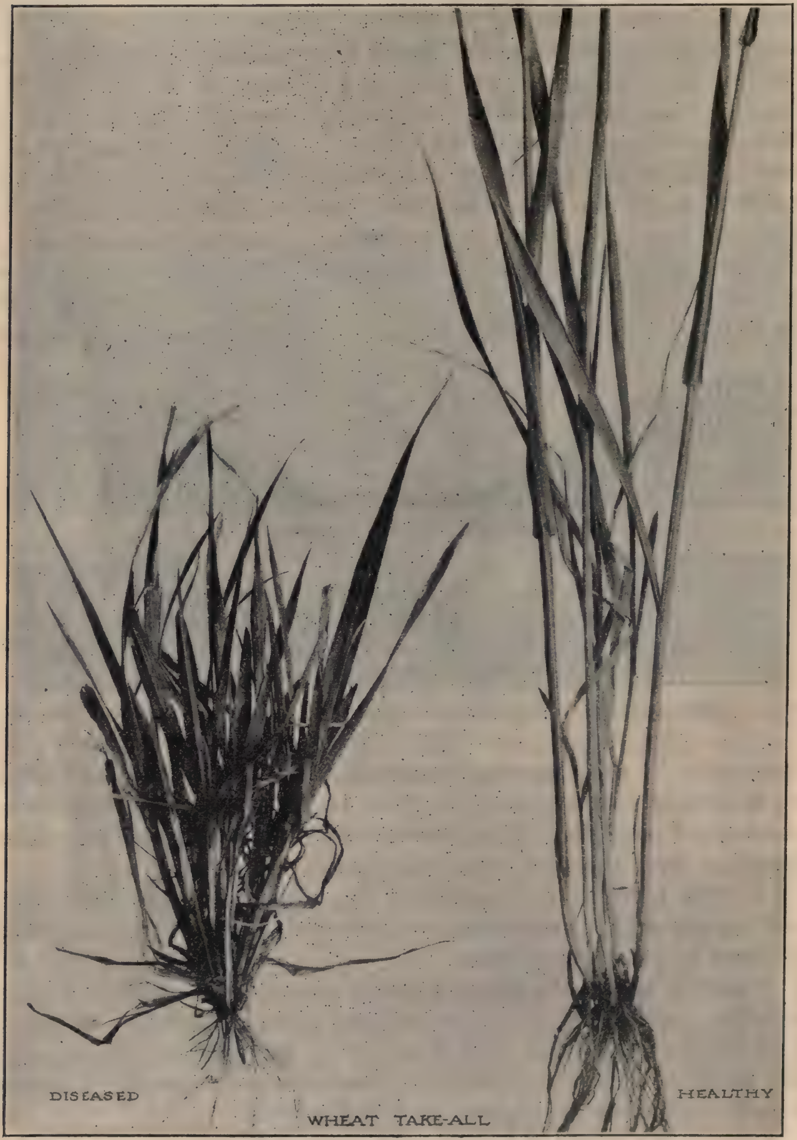

FIG. 3.—Diseased and healthy wheat plants.

browning and rotting, spring tillers become evident in excessive numbers, giving the diseased plants a "bunchy" appearance (fig. 3). Under certain soil conditions, especially when the soil is dry, some of the diseased plants die in the spring, while still in the dwarfed stage.

SYMPTOMS LATER IN THE SEASON.

When the healthy wheat plants are beginning to head, or the heads are in the "boot," the diseased plants usually show partial recovery (fig. 4) and send up one or more short, weak stems. In some cases, where soil conditions are very favorable, rather complete recovery may occur, so that the infested areas may be difficult to locate by the time the crop is mature.

When healthy plants are ripening, the diseased plants are still green. On account of this, the infested areas show up conspicuously as green spots in the ripening healthy grain. Frequently, especially in wet seasons, the development of weeds in the infested areas adds to the general green effect brought about by the green condition of the diseased plants.

When the diseased plants recover enough to develop heads, these are short and only imperfectly filled or not filled at all. This is in striking contrast with the large well-filled heads of healthy plants (fig. 5) at harvest time.

RECURRENCE.

In 1919, when the disease was first observed, it was thought by some that the trouble was caused by the exceptionally mild winter of 1918 and 1919, and considerable doubt was expressed whether the disease would reappear in a normal season. At the present time, however, there can be little doubt on this point, as the disease recurred in the spring of 1920, following a winter which was much more severe than the preceding one. From present knowledge, there is every reason to believe that the disease will recur every year when susceptible varieties of wheat are sown on infested land.

CAUSE.

The cause of the take-all has not yet been determined. A fungus (*Helminthosporium* sp.) has been found rather closely associated with the advanced stages of the trouble. The Helminthosporium disease of wheat is present in many sections of the United States, and it is possible that the take-all as it appears in Illinois and Indiana is only an unusually severe form of the common type of that disease. The exact relation of Helminthosporium to the disease found in the two States mentioned is as yet undetermined.

CONTROL.

Various control measures for the disease have been tested, and important progress has been made. It is known that the soil carries the causal factor, whatever it is. Attempts to control the disease on infested land by seed treatments, therefore, are useless. So far, there is no indication that cropping methods, summer fallow,

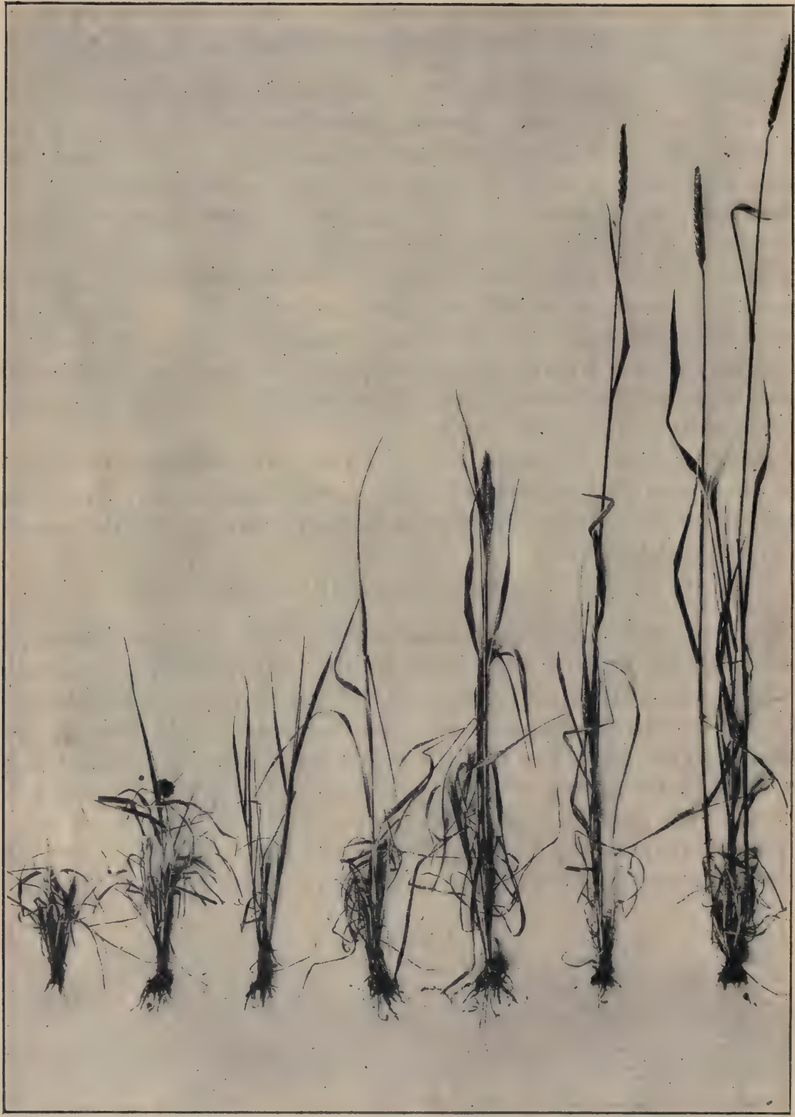

FIG. 4.—Wheat plants at the flowering stage, showing all stages of take-all injury. A healthy plant on the right.

burning the diseased stubble, or the application to the infested soil of ground limestone, fertilizers, or chemicals, such as iron sulphate, will control the disease perceptibly.

RESISTANT VARIETIES.

Preliminary experiments conducted with ten of the leading varieties of winter wheat adapted to Illinois conditions indicate that the disease can be controlled by the use of resistant varieties.

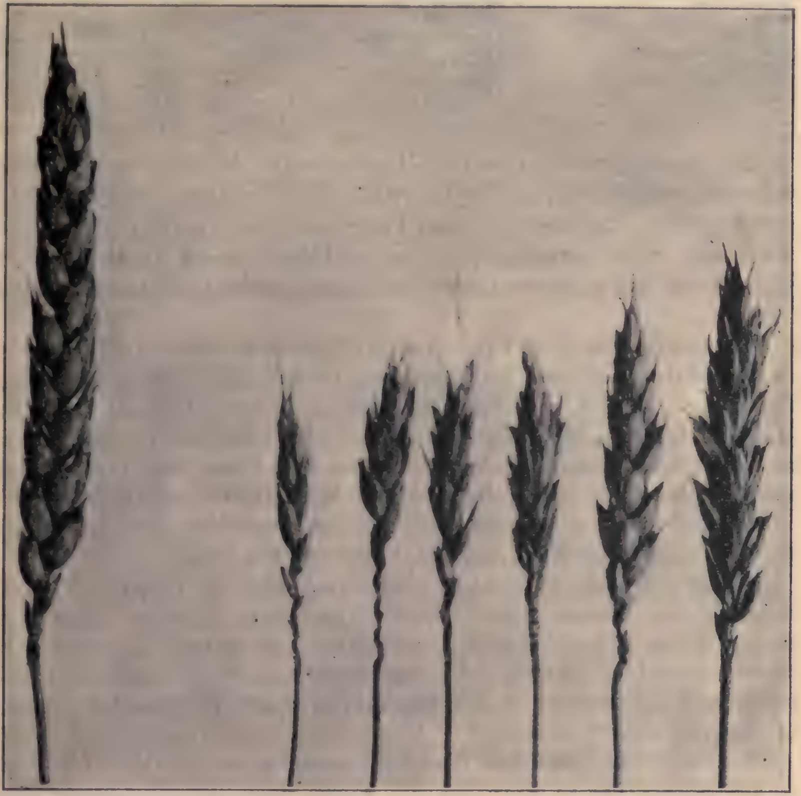

FIG. 5.—Head from a healthy wheat plant (left). Heads from diseased plants partially recovered (right).

The varieties tested were sown in adjacent parallel strips, one drill width (54 inches) wide and 50 rods long, on a uniformly infested and practically level field located near Granite City, Ill.

The results of the trials are briefly summarized in Table I. The varieties are listed in the same order in which they were sown in the plats.

It is evident from the results of the varietal experiments that Salzer Prizetaker, Red Cross, and Illini Chief are very susceptible to the disease and that the Red Wave, Early May, and Turkey varieties are apparently immune.

TABLE I.—*Resistance and susceptibility to take-all of certain varieties of wheat, as shown by tests conducted near Granite City, Ill., in 1920.*

Variety of wheat.		Take-all in plats.	Yield per acre.	Weight per bushel.
Local name.	True name.			
		Per cent.	*Bushels.*	*Pounds.*
Salzer Prizetaker	Harvest Queen	90	8.87	54.75
Red Wave	Red Wave	0	28.33	56.75
Illini Chief	Illini Chief	25 to 30	24.08	58.00
Harvest King	Harvest King	Trace.	28.83	56.50
May	Early May	0	25.61	58.50
Red Cross	Harvest Queen	78	13.51	53.00
Fultz	Fultz	2	26.20	59.50
Winter Fife	Jones Fife	2 plants.	32.87	58.50
Turkey Red	Turkey	0	21.50	60.00
Fulcaster	Fulcaster	2	25.80	60.75

The variety grown in central Illinois under the name Salzer Prizetaker has white chaff and red kernels, and it is this variety which is susceptible. The original Salzer Prizetaker was a variety with brown chaff and white kernels, but it is no longer grown in this part of Illinois and has not been tested, so its susceptibility to take-all is not known.

The susceptible Red Cross variety grown in central Illinois also has a white chaff and red kernels. It and the susceptible Salzer Prizetaker variety are identical and also are identical with the Harvest Queen. Another variety grown to some extent in the eastern United States under the name Red Cross has brown chaff and red kernels. This also has not been tested and therefore its susceptibility is not known. All of these varieties going under the names Salzer Prizetaker and Red Cross are beardless.

The Turkey variety used in these trials was the "Station" strain used at the Illinois Agricultural Experiment Station. There are many strains of Turkey wheat, and some of them have been reported to be affected by take-all. Further experiments are needed to throw additional light upon the susceptibility of the more important strains of this variety.

The Early May and Red Wave varieties have never been observed to be susceptible to the disease. These varieties often have been found sown in parts of fields of Salzer Prizetaker or Red Cross, but were always free from the disease, while the latter varieties showed severe injury.

From the experimental results it is evident that the most satisfactory means of controlling the disease lies in the discarding of the susceptible varieties in localities where the disease occurs and using only the resistant sorts. It is possible that the slight percentage of the disease apparently present in some of the varieties in 1920 was due to slight mixtures of susceptible varieties, and when perfectly pure seed is available still other varieties may be found to be resistant.

PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE RELATING TO WHEAT.

AVAILABLE FOR FREE DISTRIBUTION.

Culture of Winter Wheat in the Eastern United States. By Clyde E. Leighty. Maps 2, pp. 12. (Farmers' Bulletin 596.)

Winter Wheat Varieties for the Eastern United States. By Clyde E. Leighty. Figs. 6, pp. 14. (Farmers' Bulletin 616.)

Growing Hard Spring Wheat. By Carleton R. Ball and J. Allen Clark. Figs. 4, pp. 16. (Farmers' Bulletin 678.)

Marquis Wheat. By Carleton R. Ball and J. Allen Clark. Pp. 7. (Farmers' Bulletin 732.)

Methods of Controlling or Eradicating Wild Oats in Hard Spring Wheat Area. By H. R. Cates. Figs. 9, pp. 16. (Farmers' Bulletin 833.)

Wheat Growing in the Southeastern States. By Clyde E. Leighty. Pp. 14. (Farmers' Bulletin 885.)

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Cereal Smuts and Disinfection of Seed Grain. By Harry B. Humphrey and Alden A. Potter. Figs. 16, pp. 28. (Farmers' Bulletin 939.)

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Varietal Experiments with Spring Wheat on the Northern Great Plains. By J. Allen Clark, John H. Martin, and Ralph W. Smith. Figs 2, pls. 3, pp. 48. (Department Bulletin 878.)

Occurrence of Wheat Downy Mildew in the United States. By William H. Weston, jr. Pp. 6. (Department Circular 186.)

World's Supply of Wheat 1917. Pp. 22. (Separate 752 from Yearbook 1917.)

Cereal Diseases and National Food Supply. Pp. 16. (Separate 755 from Yearbook 1917.)

Farm Practices in Growing Wheat. Pp. 27. (Separate 804 from Yearbook 1919.)

PUBLICATIONS FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS, GOVERNMENT PRINTING OFFICE, WASHINGTON, D. C.

Durum Wheat. By Cecil Salmon and J. Allen Clark. Figs. 4, pp. 16. (Farmers' Bulletin 534.) Price, 5 cents.

Varieties of Hard Spring Wheat. By Carleton R. Ball and J. Allen Clark. Figs. 7, pp. 20. (Farmers' Bulletin 680.) Price, 5 cents.

Alaska and Stoner or Miracle Wheats. Two Varieties Much Misrepresented. By Carleton R. Ball and Clyde E. Leighty. Figs. 6, pp. 28. (Department Bulletin 357.) Price, 5 cents.

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The Origin, Characteristics, and Quality of Humpback Wheat. By Levi M. Thomas. Fig. 1, pl. 1, pp. 4. (Department Bulletin 478.) Price, 5 cents.

Wheat, Yields per Acre and Price by States, 50 Years, 1866–1915. Pp. 16. (Department Bulletin 514.) Price, 5 cents.

Characteristics and Quality of Montana-Grown Wheat. By Levi M. Thomas. Figs. 17, pls. 2, pp. 34. (Department Bulletin 522.) Price, 10 cents.

The Nematode Disease of Wheat Caused by *Tylenchus tritici*. By L. P. Byars. Figs. 6, pls. 6, pp. 40. (Department Bulletin 842.) Price, 20 cents.

Australian Wheat Varieties in the Pacific Coast Area. By J. Allen Clark, David E. Stephens, and Victor H. Florell. Pls. 3, pp. 25. (Department Bulletin 877.) Price, 10 cents.

Cost of Producing Wheat on 481 Farms of North and South Dakota, Minnesota, Kansas, Nebraska, and Missouri for the Crop Year 1919. By M. R. Cooper and R. S. Washburn. Figs. 9, pls. 2, pp. 59. (Department Bulletin 943.) Price, 15 cents.

Environment Influence on Physical and Chemical Characteristics of Wheat. (In Journal of Agricultural Research. Jan. 1914, pp. 275–291.) Price, 25 cents.

Injury to Seed Wheat Resulting from Drying After Disinfection with Formaldehyde. (In Journal of Agricultural Research. Nov. 1, 1920, pp. 209–244.) Price, 10 cents.

Yellow-berry in Hard Winter Wheat. (In Journal of Agricultural Research. Nov. 1, 1919, pp. 155–169.) Price, 20 cents.

Rust in Seed Wheat and Its Relation to Seedling Infection. (In Journal of Agricultural Research. June 15, 1920, pp. 257–277.) Price, 25 cents.

FARMERS' BULLETIN No. 1227
UNITED STATES DEPARTMENT OF AGRICULTURE

SEWAGE and SEWERAGE of FARM HOMES

DISPOSAL OF FARM SEWAGE in a clean manner is always an important problem. The aims of this bulletin are twofold: (1) To emphasize basic principles of sanitation; (2) to give directions for constructing and operating home sewerage works that shall be simple, serviceable, and safe.

Care in operating is absolutely necessary. No installation will run itself. Continued neglect ends in failure of even the best designed, best built plants. If the householder is to build and neglect, he might as well save expense and continue the earlier practice.

Contribution from the Bureau of Public Roads
THOS. H. MacDONALD, Chief
Washington, D. C. January, 1922

SEWAGE AND SEWERAGE OF FARM HOMES.

GEORGE M. WARREN,
Hydraulic Engineer, Bureau of Public Roads.

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INTRODUCTION.

The main purpose of home-sewerage works is to get rid of sewage in such way as (1) to guard against the transmission of disease germs through drinking water, flies, or other means; (2) to avoid creating nuisance. What is the best method and what the best outfit are questions not to be answered offhand from afar. A treatment that is a success in one location may be a failure in another. In every instance decision should be based upon field data and full knowledge of the local needs and conditions. An installation planned from assumed conditions may work harm. The householder may be misled as to the purification and rely on a protection that is not real. He may anticipate little or no odor and find a nuisance has been created.

PLANS AND ADVICE.

Though specific plans can not be sent in the absence of definite information, and though plans and specifications can not be prepared o meet individual requirements, the Division of Agricultural Engineering, Bureau of Public Roads, gladly gives such help as is posible. To those who contemplate installing sewerage works on farms nd who furnish the information outlined under the caption "Field data," on page 52, plans, advice, or suggestions will be sent. Local equirements are frequently met or approximated by one of the deigns on hand; working drawings in the form of blue prints will then be furnished. Sometimes the designs, slightly modified, may suit the needs. In other instances it is sufficient to send published bulletins or give written suggestions of a practical nature.

SEWAGE, SEWERS, AND SEWERAGE DEFINED.

Human excrements (feces and urine) as found in closets and privy vaults are known as night soil. These wastes may be flushed away with running water, and there may be added the discharges from washbasins, bathtubs, kitchen and slop sinks, laundry trays, washing vats, and floor drains. This refuse liquid product is sewage, and the underground pipe which conveys it is a sewer. Since sewers carry foul matter they should be water-tight, and this feature of their construction distinguishes them from drains removing relatively pure surface or ground water. Sewerage refers to a system of sewers, including the pipes, tanks, disposal works, and appurtenances.

NATURE AND QUANTITY OF SEWAGE.

Under average conditions a man discharges daily about 3½ ounces of moist feces and 40 ounces of urine, the total in a year approximating 992 pounds.[1] Feces consist largely of water and undigested or partially digested food; by weight it is 77.2 per cent water.[2] Urine is about 96.3 per cent water.[2]

The excrements constitute but a small part of ordinary sewage. In addition to the excrements and the daily water consumption of perhaps 40 gallons per person are many substances entering into the economy of the household, such as grease, fats, milk, bits of food, meat, fruit, and vegetables, tea and coffee grounds, paper, etc. This complex product contains mineral, vegetable, and animal substances, both dissolved and undissolved. It contains dead organic matter and living organisms in the form of exceedingly minute vegetative cells (bacteria) and animal cells (protozoa). These low forms of life are the active agents in destroying dead organic matter.

The bacteria are numbered in billions and include many species, some useful and others harmful. They may be termed tiny scavengers, which under favorable conditions multiply with great rapidity, their useful work being the oxidizing and nitrifying of dissolved organic matter and the breaking down of complex organic solids to liquids and gases. Among the myriads of bacteria are many of a virulent nature. These at any time may include species which are the cause of well-known infections and parasitic diseases.

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[1] Practical Physiological Chemistry, by Philip B. Hawk, 1916, pp. 221, 359.

[2] Agriculture, by F. H. Storer, 1894, vol. 2, p. 70.

SEWAGE-BORNE DISEASES AND THEIR AVOIDANCE.

Any spittoon, slop pail, sink drain, urinal, privy, cesspool, sewage tank, or sewage distribution field is a potential danger. A bit of spit, urine, or feces the size of a pin head may contain many hundred germs, all invisible to the naked eye and each one capable of producing disease. These discharges should be kept away from the food and drink of man and animals. From specific germs that may be carried in sewage at any time there may result typhoid fever, tuberculosis, cholera, dysentery, diarrhea, and other dangerous ailments, and it is probable that other maladies may be traced to human waste. From certain animal parasites or their eggs that may be carried in sewage there may result intestinal worms, of which the more common are the hookworm, roundworm, whipworm, eelworm, tapeworm, and seat worm.

Sewage, drainage, or other impure water may contain also the causative agents of numerous ailments common to live stock, such as tuberculosis, foot-and-mouth disease, hog cholera, anthrax, glanders, and stomach and intestinal worms.

Disease germs are carried by many agencies and unsuspectingly received by devious routes into the human body. Infection may come from the swirling dust of the railway roadbed, from contact with transitory or chronic carriers of disease, from green truck grown in gardens fertilized with night soil or sewage, from food prepared or touched by unclean hands or visited by flies or vermin, from milk handled by sick or careless dairymen, from milk cans and utensils washed with contaminated water, or from cisterns, wells, springs, reservoirs, irrigation ditches, brooks, or lakes receiving the surface wash or the underground drainage from sewage-polluted soil.

Many recorded examples show with certainty how typhoid fever and other diseases have been transmitted. A few indicating the responsibilities and duties of people who live in the country are cited here.

In August, 1889, a sister and two brothers aged 18, 21, and 23 years, respectively, and all apparently in robust health dwelt together in a rural village in Columbiana County, Ohio. Typhoid fever in particularly virulent form developed after use of drinking water from a badly polluted surface source. The deaths of all three occurred within a space of 10 days.

In September and October, 1899, 63 cases of typhoid fever, resulting in 5 deaths, occurred at the Northampton (Mass.) insane hospital. This epidemic was conclusively traced to celery, which was eaten freely in August and was grown and banked in a plot that had been fertilized in the late winter or early spring with the solid residue and scrapings from a sewage filter bed situated on the hospital grounds.

Some years ago Dr. W. W. Skinner, Bureau of Chemistry, Department of Agriculture, investigated the cause of an outbreak of typhoid fever in southwest Virginia. A small stream meandered through a narrow valley in which five 10-inch wells about 450 feet deep had been drilled in limestone formation. The wells were from 50 to 400 feet from the stream, from which, it was suspected, pollution was reaching the wells. In a pool in the stream bed approximately one-fourth mile above the wells several hundred pounds of common salt were dissolved. Four of the wells were cut off from the pump and the fifth was subjected to heavy pumping. The water discharged by the pump was examined at 15-minute intervals and its salt content determined over a considerable period of time. After the lapse of several 15-minute intervals the salt began to rise and continued to rise until the maximum was approximately seven times that at the beginning of the test, thus proving the facility with which pollution may pass a long distance underground and reach deep wells.

Probably no epidemic in American history better illustrates the dire results that may follow one thoughtless act than the outbreak of typhoid fever at Plymouth, Pa., in 1885. In January and February of that year the night discharges of one typhoid fever patient were thrown out upon the snow near his home. These, carried by spring thaws into the public water supply, caused an epidemic running from April to September. In a total population of about 8,000, 1,104 persons were attacked by the disease and 114 died.

Like plants and animals, disease germs vary in their powers of resistance. Some are hardy, others succumb easily. Outside the body most of them probably die in a few days or weeks. It is never certain when such germs may not lodge where the immediate surroundings are favorable to their life and reproduction. Milk is one of the common substances in which germs multiply rapidly. The experience at Northampton shows that typhoid-fever germs may survive several months in garden soil. Laboratory tests by the United States Public Health Service showed that typhoid-fever germs had not all succumbed after being frozen in cream 74 days. (Public Health Reports, Feb. 8, 1918, pp. 163–166.) Ravenel kept the spores of anthrax immersed for 244 days in the strongest tanning fluids without perceptible change in their vitality or virulence. (Annual Report, State Department of Health, Mass., 1916, p. 494.)

Unsafe practices.—Upon thousands of small farms there are no privies and excretions are deposited carelessly about the premises. A place of this character is shown in figure 1. Upon thousands of other farms the privy is so filthy and neglected that hired men and visitors seek near-by sheds, fields, and woods. A privy of this character is shown in figure 2. These practices and conditions exist in every section of the country. They should be abolished.

Deserving of severe censure is the old custom of conveying excrements or sewage into abandoned wells or some convenient stream. Such a practice is indecent and unsafe. It is unnecessary and is contrary to the laws of most of the States.

Likewise dangerous and even more disgusting is the old custom of using human excrement or sewage for the fertilization of truck land. Under no circumstances should such wastes be used on land devoted to celery, lettuce, radishes, cucumbers, cabbages, tomatoes, melons, or other vegetables, berries, or low-growing fruits that are eaten raw. Disease germs or particles of soil containing such germs may adhere to the skins of vegetables or fruits and infect the eater.

Upon farms it is necessary to dispose of excretal wastes at no great distance from the dwelling. The ability and likelihood of flies carrying disease germs direct to the dinner table, kitchen, or pantry are well known. Vermin, household pets, poultry, and live stock may spread such germs. For these reasons, and also on the score of odor, farm sewage never should be exposed.

BPR-RE 1384

FIG. 1.—One of many farms lacking the simplest sanitary convenience.

Important safety measure.—The farmer can do no other one thing so vital to his own and the public health as to make sure of the continued purity of the farm water supply. Investigations indicate that about three out of four shallow wells are polluted badly.

Wells and springs are fed by ground water, which is merely natural drainage. Drainage water usually moves with the slope of the land. It always dissolves part of the mineral, vegetable, and animal matter of the ground over or through which it moves. In this way impurities are carried into the ground water and may reach distant wells or springs.

The great safeguards are clean ground and wide separation of the well from probable channels of impure drainage water. It is not enough that a well or spring is 50 or 150 feet from a source of filth or that it is on higher ground. Given porous ground, a seamy ledge, or long-continued pollution of one plat of land, the zone of contamination is likely to extend long distances, particularly in downhill directions or when the water is low through drought or heavy pumping. Only when the surface of the water in a well or spring is at a higher level at all times than any near-by source of filth is there assurance of safety from impure seepage. Some of the foregoing facts are shown diagrammatically in figure 3. Figure 4 is typical of those insanitary, poorly drained barnyards that are almost certain to work injury to wells situated in or near them. Figure 5 illustrates poor relative location of privy, cesspool, and well. Figure 6 is a typical example of a nuisance. Accumulations of filth result in objectionable odor and noxious drainage.

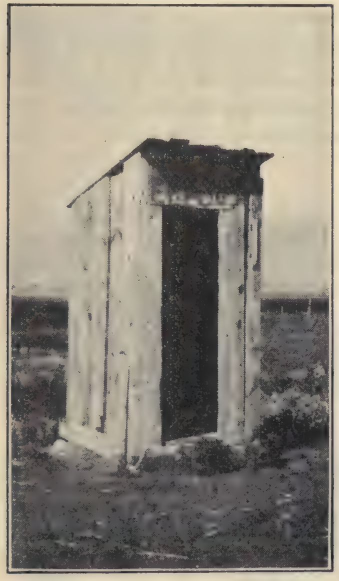

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FIG. 2.—The rickety, uncomfortable, unspeakably foul, dangerous ground privy. Neglected by the owner, shunned by the hired man, avoided by the guest, who, in preference, goes to near-by fields or woods, polluter of wells, meeting place of house flies and disease germs, privies of this character abide only because of man's indifference.

Sewage or impure drainage water should never be discharged into or upon ground draining toward a well, spring, or other source of water supply. Neither should such wastes be discharged into openings in rock, an abandoned well, nor a hole, cesspool, vault, or tank so located that pollution can escape into water-bearing earth or rock. Whatever the system of sewage disposal, it should be entirely and widely separated from the water supply. Further information on locating and constructing wells is given in Farmers' Bulletin 941, "Water Systems for Farm Homes," copies of which may be had upon request to the Division of Publications, Department of Agriculture.

Enough has been said to bring home to the reader these vital points:

1. Never allow the farm sewage or excrements, even in minutest quantity, to reach the food or water of man or live stock.
2. Never expose such wastes so that they can be visited by flies or other carriers of disease germs.
3. Never use such wastes to fertilize or irrigate vegetable gardens.

4. Never discharge or throw such wastes into a stream, pond, or abandoned well, nor into a gutter, ditch, or tile drainage system, which naturally must have outlet in some watercourse.

HOW SEWAGE DECOMPOSES.

When a bottle of fresh sewage is kept in a warm room changes occur in the appearance and nature of the liquid. At first it is light in appearance and its odor is slight. It is well supplied with oxygen, since this gas is always found in waters exposed to the atmosphere.

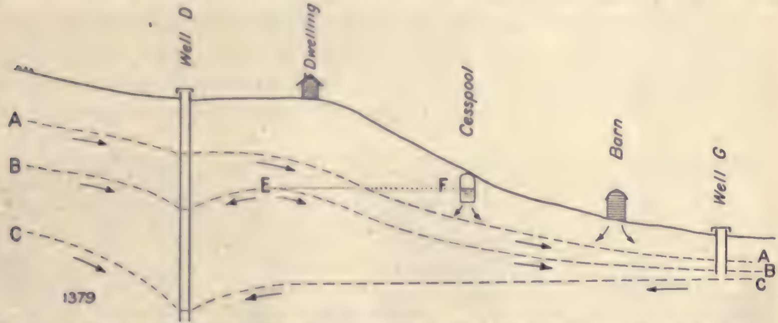

Fig. 3.—How an apparently good well may draw foul drainage. Arrows show direction of ground water movement. *A–A*, Usual water table (surface of free water in the ground); *B–B*, water table lowered by drought and pumping from well *D*; *C–C*, water table further lowered by drought and heavy pumping; *E–F*, level line from surface of sewage in cesspool. Well *D* is safe until the water table is lowered to *E*; further lowering draws drainage from the cesspool and, with the water table at *C–C*, from the barn. The location of well *G* renders it unsafe always.

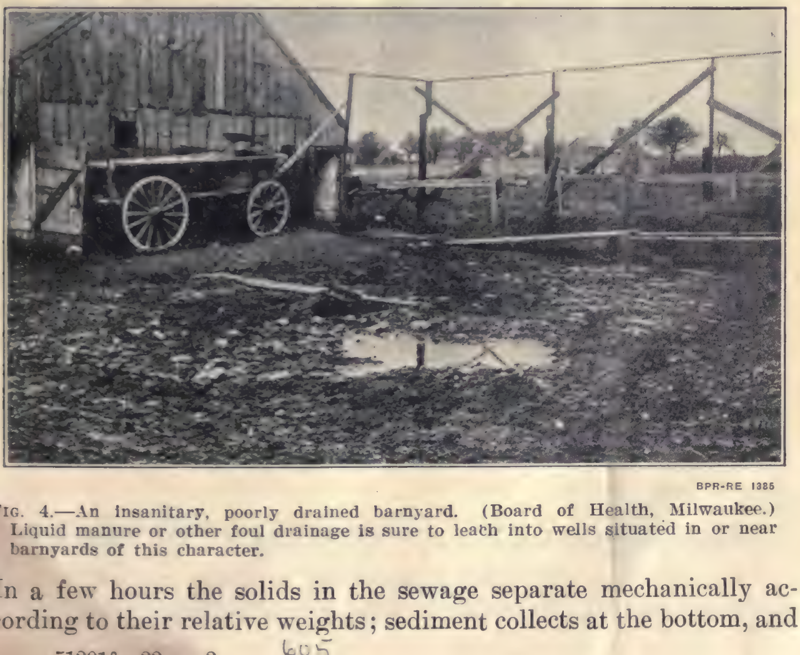

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Fig. 4.—An insanitary, poorly drained barnyard. (Board of Health, Milwaukee.) Liquid manure or other foul drainage is sure to leach into wells situated in or near barnyards of this character.

In a few hours the solids in the sewage separate mechanically according to their relative weights; sediment collects at the bottom, and

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U5age

a greasy film covers the surface. In a day's time there is an enormous development of bacteria, which obtain their food supply from the dissolved carbonaceous and nitrogenous matter. As long as free oxygen is present this action is spoken of as aërobic decomposition. There is a gradual increase in the amount of ammonia and a decrease of free oxygen, the latter going to support bacterial life. When the ammonia is near the maximum and the free oxygen is exhausted the sewage is said to be stale. Following exhaustion of the oxygen supply, bacterial life continues profuse, but it gradually diminishes as a result of reduction of its food supply and the poisonous effects of its own wastes. In the absence of oxygen the bacterial action is spoken of as anaërobic decomposition. The sewage turns darker and becomes more offensive. Suspended and settled organic substances break apart or liquefy later, and various foul-smelling gases are liberated. Sewage in this condition is known as septic and the putrefaction that has taken place is called septicization. The odor eventually disappears, and a dark, insoluble, mosslike substance remains as a deposit. Complete reduction of this deposit may require many years.

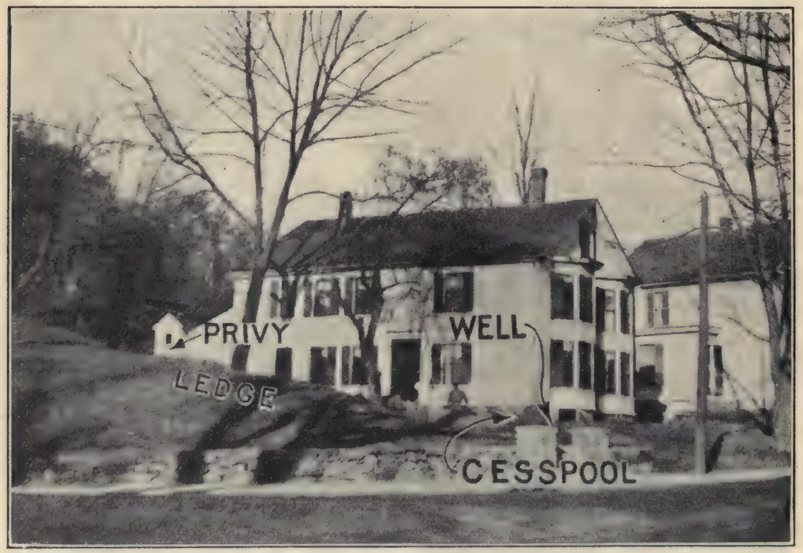

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FIG. 5.—Poor relative locations of privy, cesspool, and well. (State Department of Health, Massachusetts.) Never allow privy, cesspool, or sink drainage to escape into the plot of ground from which the water supply is taken.

IMPORTANCE OF AIR IN TREATMENT OF SEWAGE.

Decomposition of organic matter by bacterial agency is not a complete method of treating sewage, as will be shown later under

"Septic tanks." It is sufficient to observe here that in all practical methods of treatment aeration plays a vital part. The air or the sewage, or both, must be in a finely divided state, as when sewage percolates through the interstices of a porous, air-filled soil. The principle involved was clearly stated 30 years ago by Hiram F. Mills, a member of the Massachusetts State Board of Health. In discussing the intermittent filtration of sewage through gravel stones too coarse to arrest even the coarsest particles in the sewage Mr. Mills said: "The slow movement of the sewage in thin films over the surface of the stones, with air in contact, caused a removal for some months of 97 per cent of the organic nitrogenous matter, as well as 99 per cent of the bacteria."

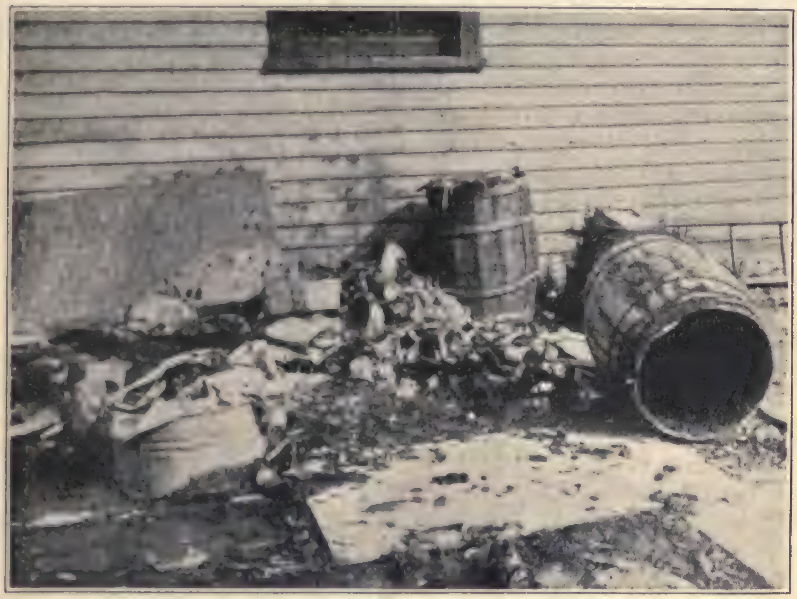

BPR-RE 1307

FIG. 6.—A typical nuisance. (Board of Health, Milwaukee.) A yard like this is an eyesore, a fire menace, a breeding place for mosquitoes and vermin, a refuge for rats and mice, a source of noxious odors and foul drainage, and a violation of every sanitation code.

PRACTICAL UTILITIES.

Previous discussion has dealt largely with basic principles of sanitation. The construction and operation of simple utilities embodying some of these principles are discussed in the following order: (1) Privies for excrements only; (2) works for handling wastes where a supply of water is available for flushing.

PIT PRIVY.

Figure 7 shows a portable pit privy suitable for places of the character of that shown in figure 1, where land is abundant and cheap, and in such localities has proved practical. It provides, at minimum cost and with least attention, a fixed place for depositing excretions where the filth can not be tracked by man, spread by animals, reached by flies, nor washed by rain.

The privy is light and inexpensive and is placed over a pit in the ground. When the pit becomes one-half or two-thirds full the privy is drawn or carried to a new location. The pit should be shallow, preferably not over 2½ feet in depth, and never should be located in wet ground or rock formation or where the surface or the strata slope toward a well, spring, or other source of domestic water supply. Besides standing on lower ground the pit should never be within 200 feet of a well or spring. Since dryness in the pit is essential, the ground should be raised slightly and 10 or 12 inches of earth should be banked and compacted against all sides to shed rain water. The banking also serves to exclude flies. If the soil is sandy or gravelly, the pit should be lined with boards or pales to prevent caving. The privy should be boarded closely and should be provided with screened openings for ventilation and light. The screens may consist of standard galvanized or black enameled wire cloth having 14 squares

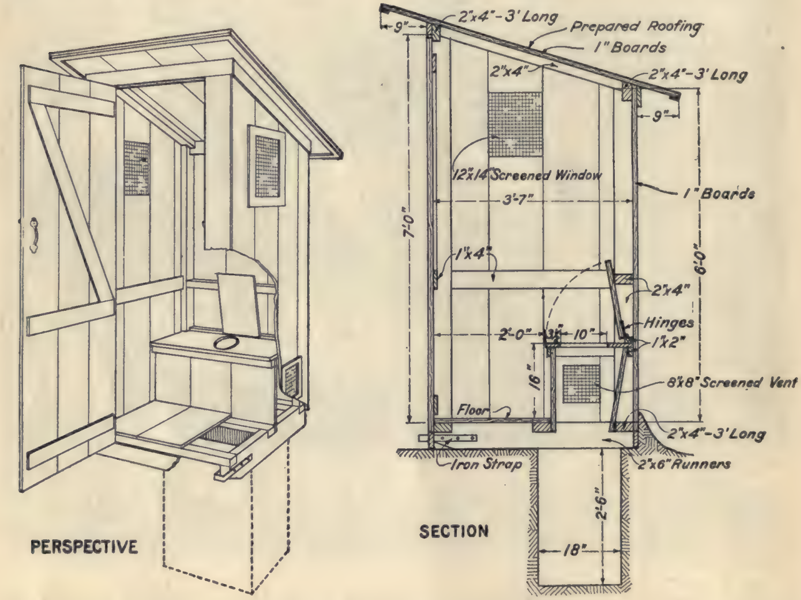


Fig. 7.—Portable pit privy. For use where land is abundant and cheap, but unless handled with judgment can not be regarded as safe. The privy is mounted on runners for convenience in moving to new locations.

to the inch. The whole seat should be easily removable for cleaning. A little loose absorbent soil should be added daily to the accumulation in the pit, and when a pit is abandoned it should be filled immediately with dry earth mounded to shed water.

A pit privy for use in field work, consisting of a framework of ½-inch iron pipe for corner posts connected at the top with ¼-inch iron rods bent at the ends to right angles and hung with curtains of unbleached muslin, is described in Public Health Report of the United States Public Health Service, July 26, 1918.

A pit privy, even if moved often, can not be regarded as safe. The danger is that accumulations of waste may overtax the purifying capacity of the soil and the leachings reach wells or springs. Sloping ground is not a guaranty of safety; the great safeguard lies in locating the privy a long distance from the water supply and as far below it as possible.

SANITARY PRIVY.

The next step in evolution is the sanitary privy. Its construction must be such that it is practically impossible for filth or germs to be spread above ground, to escape by percolation underground, or to be accessible to flies, vermin, chickens, or animals. Furthermore, it must be cared for in a cleanly manner, else it ceases to be sanitary. To secure these desirable ends sanitarians have devised numerous types of tight-receptacle privy. Considering the small cost and the proved value of some of these types, it is to be regretted that few are seen on American farms.

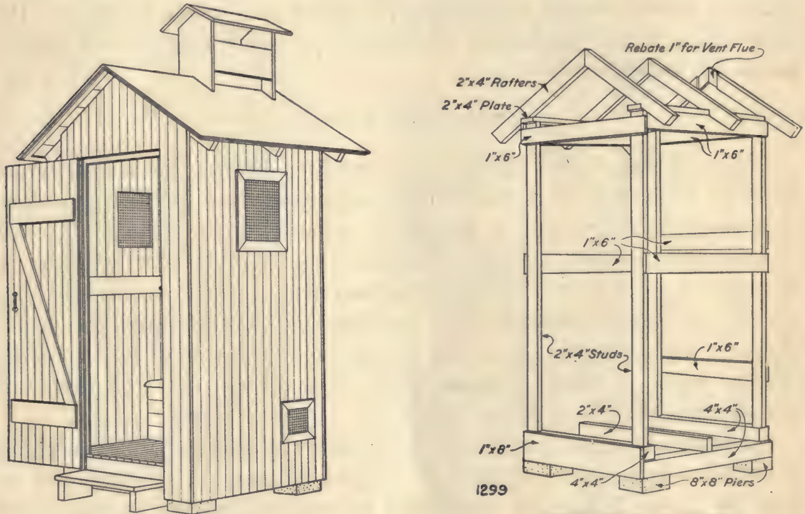
The container for a sanitary privy may be small—for example, a galvanized-iron pail or garbage can, to be removed from time to time by hand; it may be large, as a barrel or a metal tank mounted for moving; or it may be a stationary underground metal tank or masonry vault. The essential requirement in the receptacle is permanent water-tightness to prevent pollution of soils and wells. Wooden pails or boxes, which warp and leak, should not be used. Where a vault is used it should be shallow to facilitate emptying and cleaning. Moreover, if the receptacle should leak it is better that the escape of liquid should be in the top soil, where air and bacterial life are most abundant.

Sanitary privies are classified according to the method used in treating the excretions, as dry earth, chemical, liquefying.

DRY-EARTH PRIVY.

Pail type.—A very serviceable pail privy is shown in figures 8 and 9. The method of ventilation is an adaptation of a system that has proved very effective in barns and other buildings here and abroad.

A flue with a clear opening of 16 square inches rises from the rear of the seat and terminates above the ridgepole in a cowl or small roofed housing. Attached to this flue is a short auxiliary duct, 4 by 15 inches, for removing foul air from the top of the privy. In its upper portion on the long sides the cowl is open, allowing free movement of air across the top of the flue. In addition the long sides of the cowl are open below next to the roof. These two openings, with the connecting vertical air passages, permit free upward movement of air through the cowl, as indicated by the arrows. The combined effect is to create draft from beneath the seat and from the top of the privy. The ventilating flue is 2 by 8 inches at the seat and 4 by 4 inches 5 feet above. The taper slightly increases the labor of making the flue, but permits a 2-inch reduction in the length of the building.



PERSPECTIVE

PERSPECTIVE OF FRAMING

Fig. 8.—Pail privy. Well constructed, ventilated, and screened. With proper care is sanitary and unobjectionable.

In plan the privy is 4 by 4½ feet. The sills are secured to durable posts set about 4 feet in the ground. The boarding is tight, and all vents and windows are screened to exclude insects. The screens may be the same as for pit privies or, if a more lasting material is desired, bronze or copper screening of 14 squares to the inch may be used. The entire seat is hinged, thus permitting removal of the receptacle and facilitating cleaning and washing the underside of the seat and the destruction of spiders and other insects which thrive in dark, unclean places. The receptacle is a heavy galvanized-iron garbage can. Heavy brown-paper bags for lining the can may be had at slight cost, and their use helps to keep the can clean and facilitates empty-

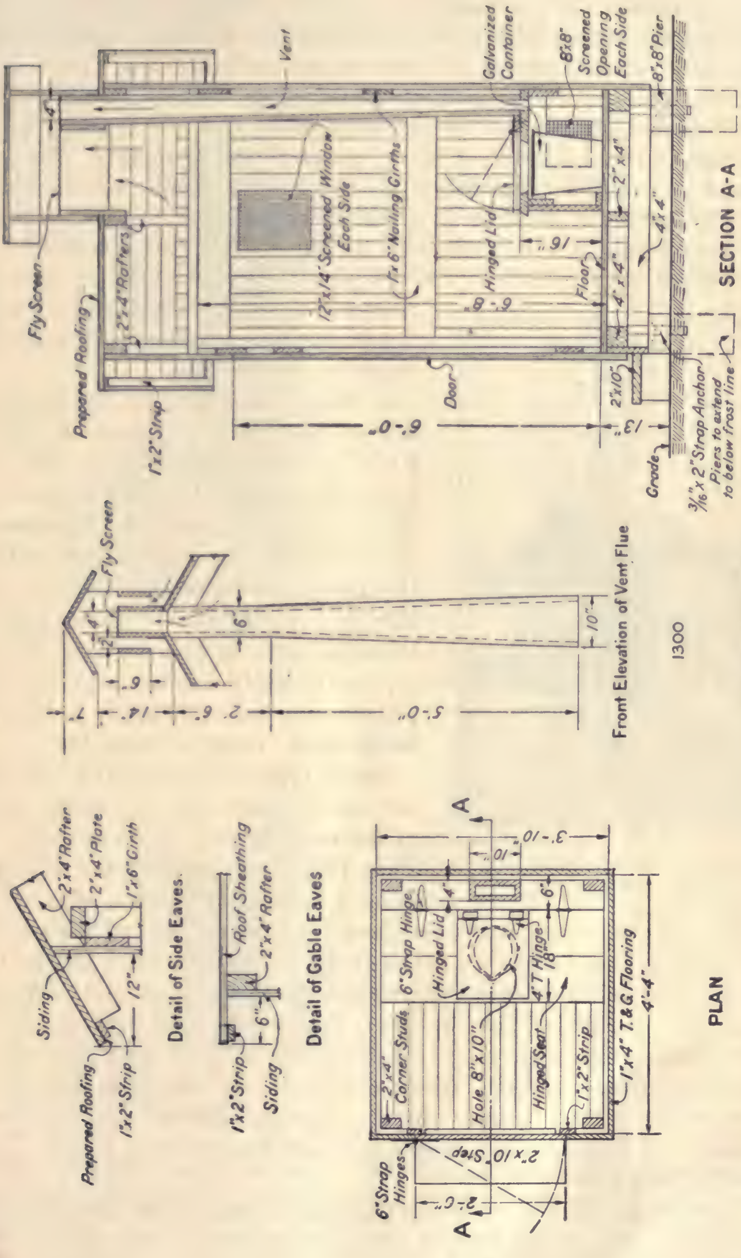


FIG. 9.—Pail privy.

ing. Painting with black asphaltum serves a similar purpose and protects the can from rust. If the contents are frozen, a little heat releases them. Of nonfreezing mixtures a strong brine made with common salt or calcium chloride is effective. Two and one-half to 3 pounds of either thoroughly dissolved in a gallon of water lowers the freezing point of the mixture to about zero. Denatured alcohol or wood alcohol in a 25 per cent solution has a like low freezing point and the additional merit of being noncorrosive of metals. The can should be emptied frequently and the contents completely buried in a thin layer by a plow or in a shallow hand-dug trench at a point below and remote from wells and springs. Wherever intestinal disease exists the contents of the can should be destroyed by burning or made sterile before burial by boiling or by incorporation with a strong chemical disinfectant.

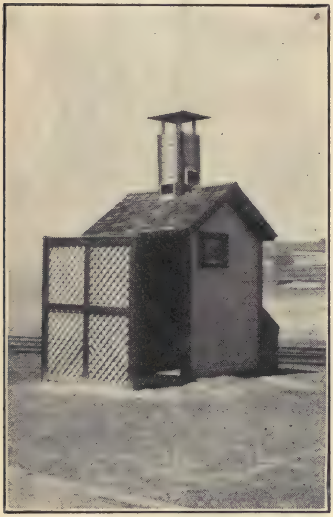

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FIG. 10.—A well-ventilated privy in Montana.

A privy ventilated in the manner before described is shown in figure 10. The cowl, however, is open on four sides instead of two sides as shown in figures 8 and 9. The working drawings (fig. 8 and 9) show that the construction of a privy of the kind is not difficult. Figure 11 gives three suggestions whereby a privy may be conveniently located and the approach screened or partially hidden by latticework, vines, or shrubbery.

Vault type.—A primitive and yet serviceable three-seat dry-earth privy of the vault type is shown in figure 12. This privy was constructed in 1817 upon a farm at Westboro, Mass. The vault, made of bricks, was 6 feet long by 5 feet wide, and the bottom was 1 foot below the surface of the ground. The brickwork was laid in mortar, and the part below the ground surface was plastered on the inside. The outside of the vault was exposed to light and air on all four sides. Across the long side of the vault in the rear was a door swinging upward through which the night soil was removed two or three times a year, usually in the spring, summer, and fall, and hauled to a near-by field, where it was deposited in a furrow, just ahead of the plow.

Especial attention is called to the shallowness of the vault and the lightened labor of cleaning it out. The swinging door at the rear facilitated the sprinkling of dry soil or ashes over the contents of the vault, thus avoiding the necessity of carrying dirt and dust into the building and dust settling upon the seat. This privy was in use for nearly 100 years without renewal or repairs. When last seen the original seat, which always was kept painted, showed no signs of decay. Modern methods would call for a concrete vault of guaranteed water-tightness,[3] proper ventilation and screening, and hinging the seat.

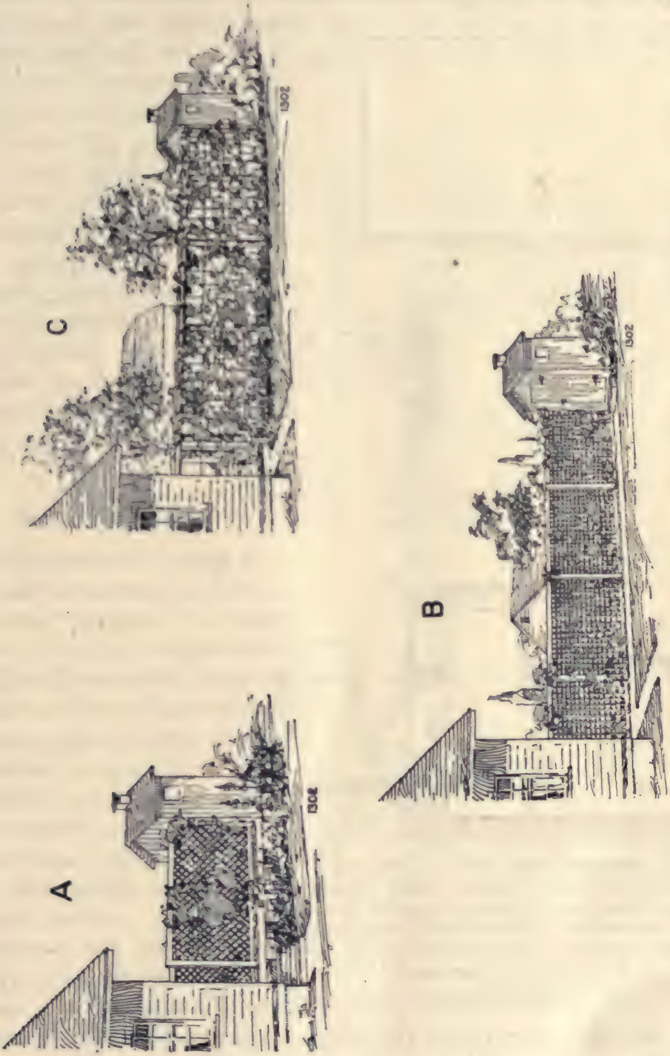

FIG. 11.—Screening the approach to a privy. *A*, Raised platform with lattice sides, suitable for short distances, convenient and easily cleared of snow; *B*, walk hidden by lattice work; *C*, walk inclosed by an arbor.

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[3] Directions for mixing and placing concrete to secure water-tightness are contained in an article entitled "Securing a dry cellar," U. S. Department of Agriculture Yearbook, 1919; published also as Yearbook Separate No. 824, and obtainable for 10 cents from the Superintendent of Documents, Government Printing Office, Washington, D. C.

Working drawings for a very convenient well-built two-seat vault privy are reproduced in figures 13 and 14. The essential features are shown in sufficient detail to require little explanation. With concrete mixtures of 1:2:3 (1 volume cement, 2 volumes sand, 3 volumes stone) for the vault and 1:2:4 for the posts there will be required a total of about 2 cubic yards of concrete, taking 3½ barrels of cement, 1 cubic yard of sand, and 1½ cubic yards of broken stone or screened gravel. The stone or gravel should not exceed 1 inch in diameter, except that a few cobblestones may be embedded where the vault wall is thickest, thus effecting a slight saving of materials.

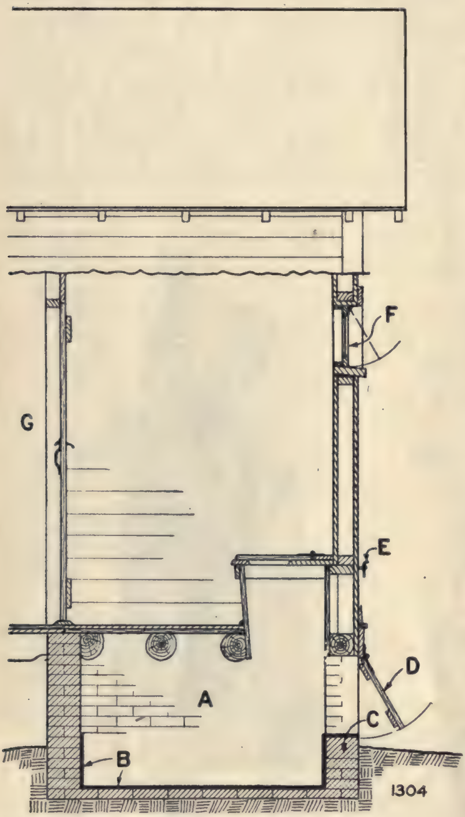

Fig. 12.—A primitive vault privy in Massachusetts. Note the tight, shallow, easily cleaned vault. *A,* Brick vault 5 by 6 feet, bottom about 1 foot in the ground; *B,* water-tight plastering; *C,* rowlock course of brick; *D,* door hinged at top; *E* door button; *F,* three-pane window hinged at top; *G* passageway.

CHEMICAL CLOSET.

A type of sanitary privy in which the excrements are received directly into a water-tight receptacle containing chemical disinfectant is meeting with considerable favor for camps, parks, rural cottages, schools, hotels, and railway stations. These chemical closets,[4] as they are called, are made in different forms and are known by various trade names. In the simplest form a sheet-metal receptacle is concealed in a small metal or wooden cabinet, and the closet is operated usually in much the same manner as the ordinary pail privy. These closets are very simple and compact, of good appearance, and easy to install or move from place to place. In another type, known as the chemical tank closet, the receptacle is a steel tank fixed in position underground or in a basement. The tank has a capacity of about 125 gallons per seat, is provided with a hand-operated agitator to secure thorough mixing of the chemical and the excretions, and the contents are bailed, pumped, or drained out from time to time.

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[4] Among publications on chemical closets are the following: "Chemical Closets," Reprint No. 404 from the Public Health Reports, U. S. Public Health Service, June 29, 1917, pp. 1017–1020; "The Chemical Closet," Engineering Bulletin No. 5, Mich. State Board of Health, October, 1916; Health Bulletin, Va. Department of Health, March, 1917, pp. 214–219.

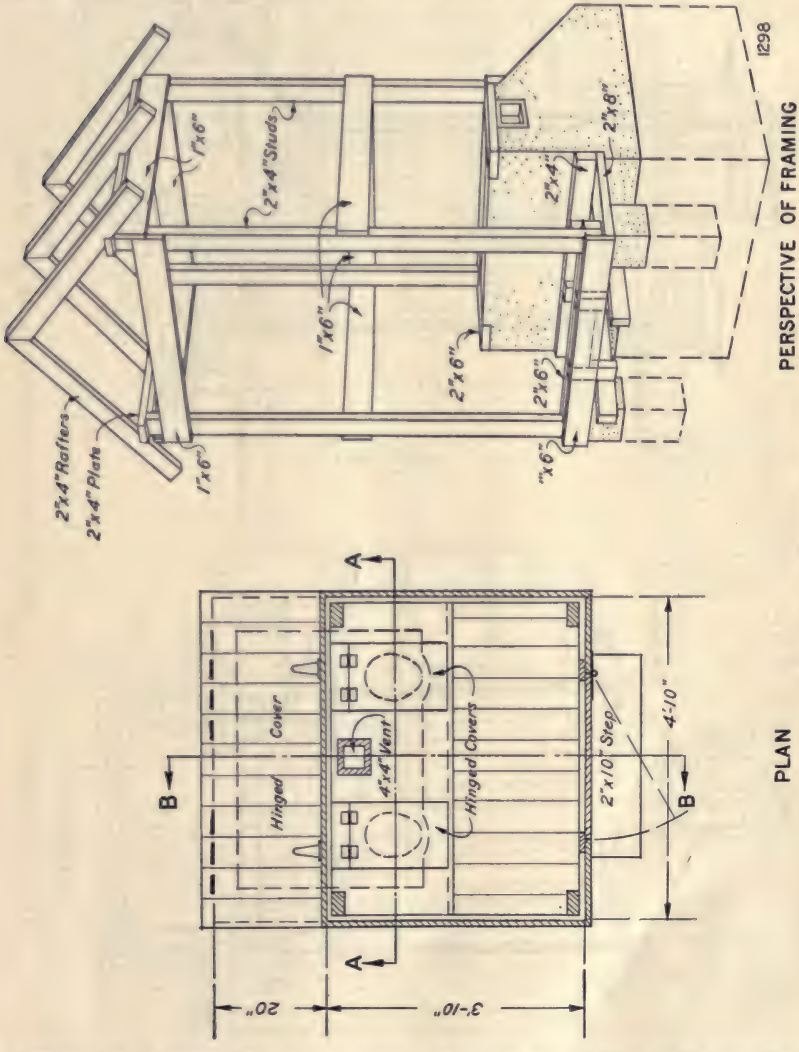

Fig. 13.—Two-seat vault privy.

Chemical closets, like every form of privy, should be well installed, cleanly operated, and frequently emptied, and the wastes should receive safe burial. With exception of frequency of empyting, the same can be said of chemical tank closets. With both forms of closet thorough ventilation or draft is essential, and this is obtained usually by connecting the closet vent pipe to a chimney flue or extending it well above the ridgepole of the building. The contents of the container should always be submerged and very low temperatures guarded against.

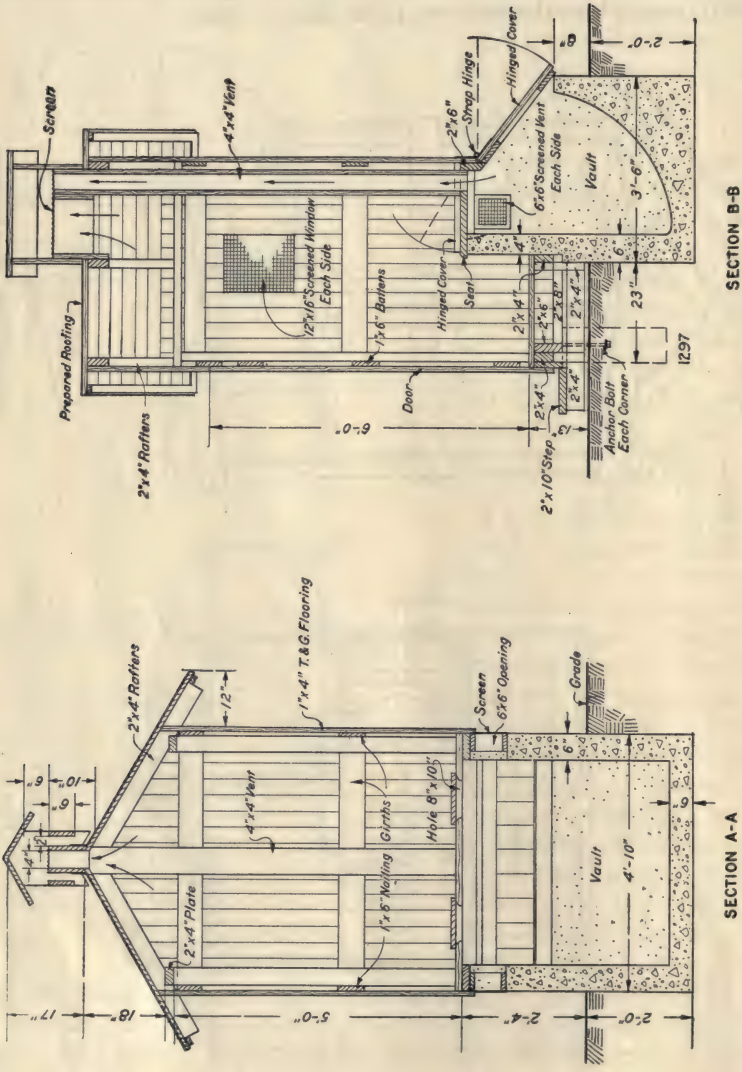

FIG. 14.—Two-seat vault privy. Note the shallow, water-tight, easily cleaned concrete vault.

As to the germicidal results obtained in chemical closets, few data are available. A disinfecting compound may not sterilize more than a thin surface layer of the solid matter deposited. Experiments by Dr. Alvah H. Doty with various agents recommended and widely used for the bedside sterilization of feces showed "that at the end of 20 hours of exposure to the disinfectant but one-eighth of an inch of the fecal mass was disinfected."[5] Plainly, then, to destroy all bacterial and parasitic life in chemical closets three things are necessary: (1) A very powerful agent; (2) permeation of the fecal mass by the agent; (3) retention of its strength and potency until permeation is complete. The compounds or mixtures commonly used in chemical closets are of two general kinds: First, those in which some coal-tar product or other oily disinfectant is used to destroy germs and deodorize, leaving the solids little changed in form; second, those of the caustic class that dissolve the solids, which, if of sufficient strength and permeating every portion, should destroy most if not all bacterial life. Not infrequently the chemical

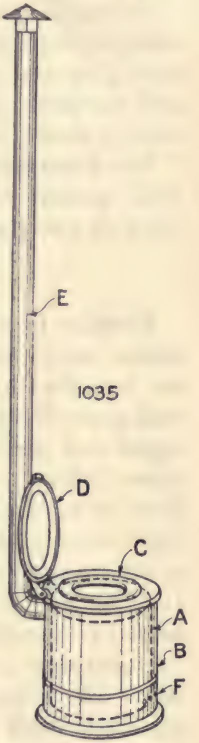

Fig. 15.—Chemical closet. *A*, Water-tight sheet-metal container; *B*, metal or wooden cabinet; *C*, wooden or composition seat ring; *D*, hinged cover; *E*, 3 or 4 inch ventilating flue extending 18 inches above roof or to a chimney; *F*, air inlets.

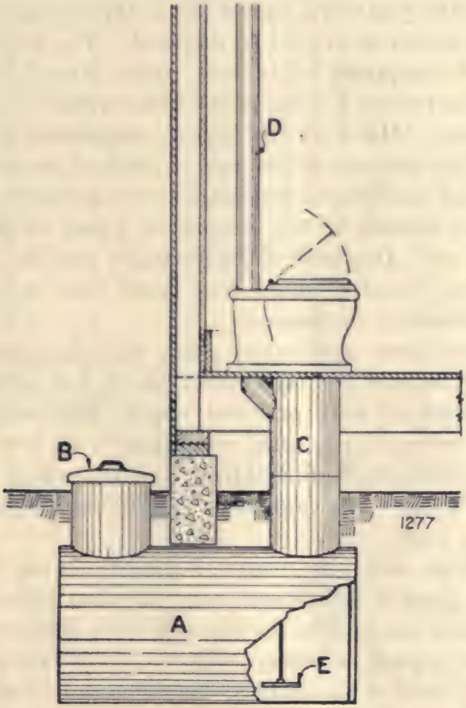

Fig. 16.—Chemical tank closet. *A*, Tank, 2 feet 3 inches by 4 feet 2 inches, $\frac{5}{16}$-inch iron, seams welded, capacity 125 gallons; *B*, 14-inch covered opening for recharging and emptying tank; *C*, 12-inch galvanized sheet-metal tube; *D*, 4-inch sheet-metal ventilating pipe extending above ridge-pole or to a chimney; *E*, agitator or paddle.

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[5] Annual Report, Mass. State Board of Health, 1914, p. 727.

solution is intended to accomplish disinfection, deodorization, and reduction to a liquid or semiliquid state.

A simple type of chemical closet is shown in figure 15, and the essential features are indicated in the notation. These closets with vent pipe and appurtenances, ready for setting up, retail for $20 and upward. A chemical tank closet. retailing for about $80 per seat, is shown in figure 16.

The Department of Agriculture occasionally receives complaints from people who have installed chemical closets, usually on the score of odors or the cost of chemicals.

LIQUEFYING CLOSET.

Another type of sanitary privy, known as a liquefying closet, makes use of bacterial action as an aid to disposal. The excretions are deposited in a tight receptacle containing water, where fermentation and decomposition reduce a large part of the organic solids to liquid and gaseous forms. Much of the liquid evaporates and the gases diffuse, so that the volume of sewage is reduced materially. More or less insoluble and undigested residue, known as sludge, gradually accumulates at the bottom of the receptacle, which from time to time must be cleaned out. Disposal of the partially clarified liquid and the sludge, however, involves much less labor than would be needed to handle the untreated excrements.

Liquefying closets have been used many years with fair satisfaction. The receptacle sometimes is a tight brick vault, but more frequently a barrel or hogshead with one end nearly flush with the ground. Over this is mounted the seat, sometimes with iron bars beneath to prevent accident to small children, and the whole is inclosed in a small frame house. The vault usually is bailed or pumped out two or three times a year.

Upon farms where slope, soil, and drainage conditions are favorable the effluent from liquefying closets may be distributed and aerated by means of drain tile laid in the top soil or in shallow beds filled with cinders, coke, gravel, or stone. Figure 17 shows a simple one-chamber liquefying closet with shallow distribution of the effluent in a stone-filled trench. The vault or tank consists of vitrified sewer pipe, a simple and cheap construction. Where a larger vault is required concrete or brick may be used, the usual capacity being 12 or 13 gallons to a person.

Faults in liquefying closets are objectionable odor, clogging of the screen over the outlet, or insufficient water in the vault to insure proper bacterial action. A ventilating pipe should be provided extending from beneath the seat to above the roof. The outlet pipe should not be less than 4 inches in diameter, and the mesh of the screen should not be less than one-fourth inch. The contents of

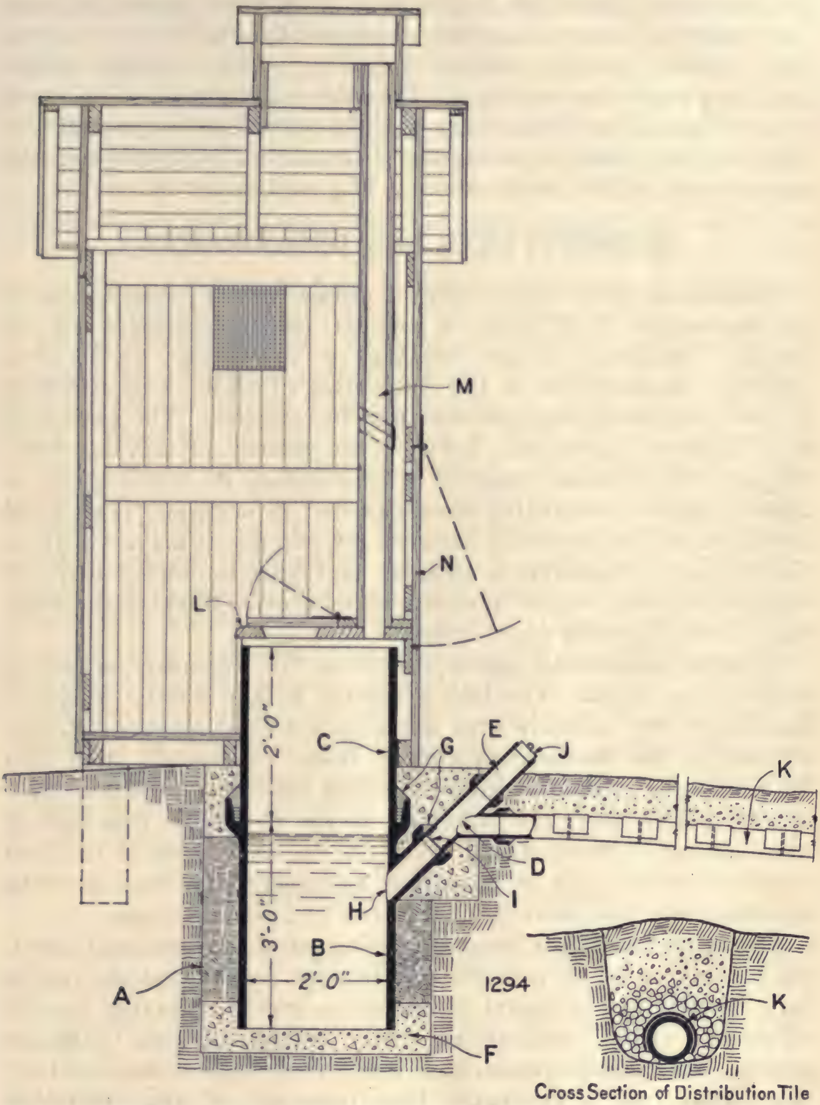

FIG. 17.—Liquefying closet. *A*, Excavation about 3 feet 3 inches in diameter; *B*, 3-foot length, vitrified Y branch, 24 by 4 inches; *C*, 2-foot length of 24-inch hard burned drain tile or vitrified sewer pipe; *D*, 4 by 4 inch Y branch; *E*, 1-foot length of 4-inch cast-iron soil pipe; *F*, concrete bottom making water-tight seal; *G*, joints made water tight by use of a strand of jute or oakum and rich Portland cement mortar or hot bituminous jointing compound; *H*, submerged outlet; *I*, removable strainer with openings ¼ inch or larger; *J*, 4-inch removable plug; *K*, 4-inch drain tile laid on good slope in trench about 15 inches deep, ends of tile butting, joints covered with strips of tarred paper extending three-fourths of the way around the tile; *L*, removable seat supported by end cleats; *M*, 4 by 4 inch ventilating flue, bottom portion removable; *N*, hinged door to facilitate bailing out sludge.

the vault should be diluted with water at intervals, depending upon the number of persons using the closet and the rapidity of evaporation. Dilution may be effected by pouring in 1 or 2 gallons with a pail, or a small pipe may be led from the eaves trough of the closet to the vault. The effluent may be light colored and apparently inoffensive, but it still is sewage, and therefore the distributing tile never should be laid in the vicinity of a well or spring.

DISINFECTANTS AND DEODORANTS.

Disinfection is the destruction of disease germs. Sterilization is the destruction of all germs or bacteria, both the harmful and the useful. Antisepsis is the checking or restraining of bacterial growth. Deodorization is the destruction of odor. Unfortunately in practice none of these processes may be complete. The agent may be of inferior quality, may have lost its potency, or may not reach all parts of the mass treated. A disinfectant or germicide is an agent capable of destroying disease germs; an antiseptic is an agent merely capable of arresting bacterial growth, and it may be a dilute disinfectant; a deodorant is an agent that tends to destroy odor, but whose action may consist in absorbing odor or in masking the original odor with another more agreeable one.[6]

Of active disinfecting agents, heat from fire, live steam, or boiling water is the surest. The heat generated by the slaking of quicklime has proved effective with small quantities of excreta. Results of tests by the Massachusetts State Board of Health[7] show that the preferable method consists in adding sufficient hot water (120° to 140° F.) to cover the excrement in the receptacle, then adding small pieces of fresh strong quicklime in amount equal to about one-third of the bulk of water and excrement combined, covering the receptacle, and allowing it to stand 1½ hours or longer.

Among chemical disinfectants a strong solution of sodium hydroxide (caustic soda) or potassium hydroxide (caustic potash, lye) is very effective and is useful in dissolving grease and other organic substances. Both chemicals are costly, but caustic soda is less expensive than caustic potash and constitutes most of the ordinary commercial lyes. Chlorinated lime (chloride of lime, bleaching powder) either in solution or in powdered form is valuable. For the disinfection of stools of typhoid-fever patients the Virginia State Board of Health[8] recommends thoroughly dissolving ½ pound of best chloride of lime in 1 gallon of water and allowing the solution to cover the feces for at least 1 hour. The solution should be kept in well-stoppered bottles and used promptly, certainly within 2 or 3 days. Copper sulphate (blue vitriol, bluestone) in a 5 per cent solution (1 pound in 2½ gallons of water) is a good but rather costly disinfectant. None of the formulas here given is to be construed as fixed and precise. Conditions may vary the proportions, as they always will vary the results. The reader should remember that few, if any, chemical disinfectants can be expected fully to disinfect or sterilize large masses of excrement unless the agent is used repeatedly and in liberal quantities or mechanical means are employed to secure thorough incorporation.

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[6] Those desiring more explicit information on disinfectants and the principles of disinfection are referred to U. S. Department of Agriculture Farmers' Bulletins 926, "Some Common Disinfectants," and 954, "The Disinfection of Stables," and to publications of the U. S. Public Health Service.

[7] Annual Report, Mass. State Board of Health, 1914, pp. 727–729.

[8] Health Bulletin, Va. State Board of Health, June, 1917, pp. 277–280.

Among deodorants some of the drying powders mentioned below possess more or less disinfecting power. Chloride of lime, though giving off an unpleasant odor of chlorine, is employed extensively. Lime in the form of either quicklime or milk of lime (whitewash) is much used and is an active disinfectant. To prepare milk of lime a small quantity of water is slowly added to good fresh quicklime in lumps. As soon as the quicklime is slaked a quantity of water, about four times the quantity of lime, is added and stirred thoroughly. When used as a whitewash the milk of lime is thinned as desired with water and kept well stirred. Liberal use of milk of lime in a vault or cesspool, though it may not disinfect the contents, is of use in checking bacterial growth and abating odor. To give the best results it should be used frequently, beginning when the vault or cesspool is empty. Iron sulphate (green vitriol, copperas) because of its affinity for ammonia and sulphides is used as a temporary deodorizer in vaults, cesspools, and drains; 1 pound dissolved in 4 gallons of water makes a solution of suitable strength.

PREVENTION OF PRIVY NUISANCE.

The following is a summary of simple measures for preventing a privy from becoming a nuisance:

1. Locate the privy inconspicuously and detached from the dwelling.
2. Make the receptacle or vault small, shallow, easy of access, and water-tight.
3. Clean out the vault often. Do not wait until excrement has accumulated and decomposition is sufficiently advanced to cause strong and foul odors.
4. Sprinkle into the vault daily loose dry soil, ashes, lime, sawdust, ground gypsum (land plaster), or powdered peat or charcoal. These will absorb liquid and odor, though they may not destroy disease germs.
5. Make the privy house rain-proof; ventilate it thoroughly, and screen all openings.

OBJECTION TO PRIVIES.

All the methods of waste disposal heretofore described are open to the following objections:

1. They do not take care of kitchen slops and liquid wastes incident to a pressure water system.
2. They retain filth for a considerable period of time with probability of odors and liability of transmission of disease germs.
3. They require more personal attention and care than people generally are willing to give.

By far the most satisfactory method yet devised of caring for sewage calls for a supply of water and the flushing away of all wastes as soon as created through a water-tight sewer to a place where they undergo treatment and final disposal.

KITCHEN-SINK DRAINAGE.

A necessity in every dwelling is effective disposal of the kitchen-sink slops. This necessity ordinarily arises long before the farm home is supplied with water under pressure and the conveniences that go with it. Hence the first call for information on sewage disposal is likely to relate merely to sink drainage. This waste water though it may not be as dangerous to health as sewage containing human excrements is still a menace to the farm well and capable of creating disagreeable odor.

The usual method of disposing of sink slops is to allow them to dribble on or beneath the surface of the ground close to the house. Such drainage should be taken in a water-tight carrier at least 100 feet downhill from the well and discharged below the surface of the ground. Every sink should be provided with a suitable screen to keep all large particles out of the waste pipe. An approved form of sink strainer consists of a brass plate bolted in position over the outlet and having at least 37 perforations not larger than one-fourth inch in diameter. Provided a sink is thus equipped and is given proper care and the land has fair slope and drainage, the waste water may be conducted away through a water-tight sewer and distributed in the soil by means of a short blind drain. The blind drain may be conveniently made of drain tile in the manner shown in figure 17. A simple installation, consisting of a kitchen sink and pump and means of disposal as described, is shown in figure 18.

CESSPOOLS.

Where farms have water under pressure an open or leaching cesspool is a common method of disposing of the sewage. Ordinary cesspools are circular excavations in the ground, lined with stone or brick laid without mortar. They vary from 5 to 10 feet in diameter and from 7 to 12 feet in depth. Sometimes the top is arched and capped at the ground surface by a cover of wood, stone, or cast iron. At other times the walls are carried straight up and boards or planks are laid across for a cover, and the entire structure is hidden with a hedge or shrubbery.

Except under the most favorable conditions the construction and use of a cesspool can not be condemned too strongly. They are only permissible where no other arrangement is possible. Leaching cesspools especially are open to these serious objections:

1. Unless located in porous soil, stagnation is likely to occur, and failure of the liquid to seep away may result in overflow on the surface of the ground and the creation of a nuisance and a menace.

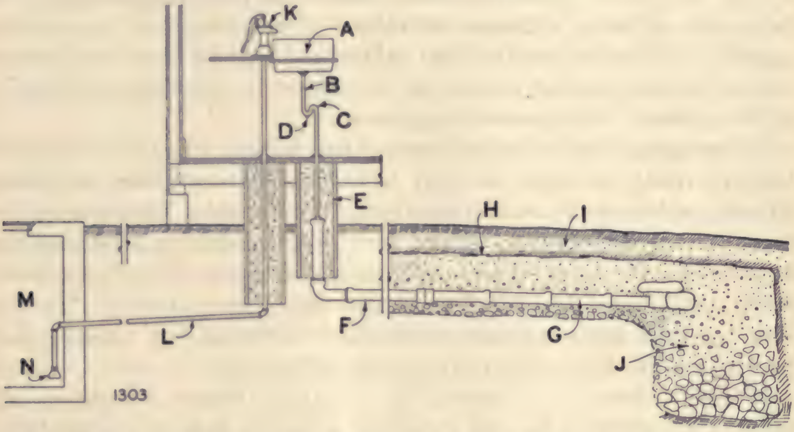

FIG. 18.—How to waste kitchen-sink drainage. *A*, Sink; *B*, waste pipe; *C*, trap; *D*, cleanout; *E*, box filled with hay, straw, sawdust, excelsior, coke, or other insulating material; *F*, 4-inch vitrified sewer-pipe, hubs uphill, and joints made water tight for at least 100 feet downhill from a well; *G*, 4-inch vitrified sewer pipe, hubs downhill, joints slightly open, laid in an 18-inch bed of coarse sand, gravel, stone, broken brick, slag, cinders, or coke; *H*, strip of tarred paper on burlap or a thin layer of hay, straw, cornstalks, brush, or sods, grass side down; *I*, 12 inches of natural soil; *J*, stone-filled pit. As here illustrated, water is drawn by a pitcher or kitchen pump (*K*) through a 1¼ or 1½ inch galvanized-iron suction pipe (*L*) from a cistern (*M*). The suction pipe should be laid below frost and on a smooth upward grade from cistern to pump and be provided with a foot valve (*N*) to keep the pump primed. If a foot valve is used, pump and pipe must be safe from frost or other means than tripping the pump be provided for draining the system.

2. They retain a mass of filth in a decomposing condition deep in the ground where it is but slightly affected by the bacteria and air of the soil. In seeping through the ground it may be strained, but there can be no assurance that the foul liquid with little improvement in its condition may not pass into the ground water and pollute wells and springs situated long distances away in the direction of underground flow.

For the purpose of avoiding soil and ground-water pollution cesspools have been made of water-tight construction and the contents removed by bailing or pumping. Upon the farm, however, this type of construction has little to recommend it, for the reason that facilities for removing and disposing of the contents in a clean manner are lacking.

In some instances cesspools have been made water-tight, the outflow being effected by three or four elbows or T-branches set in the masonry near the top, with the inner ends turned down below the water surface, the whole surrounded to a thickness of several feet with stone or gravel intended to act as a filtering medium. Tests of the soil water adjacent to cesspools of this type show that no reliance should be placed upon them as a means of purifying sewage, the fatal defects being constant saturation with sewage and lack of air supply. To the extent that the submerged outlets keep back grease and solid matters the scheme is of service in preventing clogging of the pores of the surrounding ground.

Where the ground about a cesspool has become clogged and waterlogged, relief is often secured by laying several lines of drain tile at shallow depth, radiating from the cesspool. The ends of the pipes within the cesspool should turn down, and it is advantageous to surround the lines of pipe with stones or coarse gravel, as shown in figures 17 and 18 and discussed under "Septic tanks." In this way not only is the area of percolation extended, but aeration and partial purification of the sewage are effected.

Where a cesspool is located at a distance from a dwelling and there is opportunity to lead a vent pipe up the side of a shed, barn, or any stable object it is advisable to do so for purposes of ventilation. Where the conditions are less favorable it may be best, because of the odor, to omit any direct vent pipe from the cesspool and rely for ventilation on the house sewer and main soil stack extending above the roof of the house.

Cesspools should be emptied and cleaned at least once a year and the contents given safe burial or, with the requisite permission, wasted in some municipal sewerage system. After cleaning, the walls and bottom may be treated with a disinfectant or a deodorant.

SEPTIC TANKS.

A tight, underground septic tank with shallow distribution of the effluent in porous soil generally is the safest and least troublesome method of treating sewage upon the farm, while at the same time more or less of the irrigating and manurial value of the sewage may be realized.

The late Prof. Kinnicutt used to say that a septic tank is "simply a cesspool, regulated and controlled." The reactions described under the captions "How sewage decomposes," "Liquefying closet," and "Cesspools" take place in septic tanks.

In all sewage tanks, whatever their size and shape, a portion of the solid matter, especially if the sewage contains much grease, floats as scum on the liquid, the heavier solids settle to form sludge, while finely divided solids and matter in a state of emulsion are held in suspension. If the sludge is retained in the bottom of the tank and converted or partly converted into liquids and gases the tank is called a septic tank and the process is known as septicization. The process is sometimes spoken of as one of digestion or rotting.

History.—Prototypes of the septic tank were known in Europe nearly 50 years ago. Between 1876 and 1893 a number of closed tanks with submerged inlets and outlets embodying the principle of storage of sewage and liquefaction of the solids were built in the United States and Canada. It was later seen that many of the early claims for the septic process were extravagant. In recent years septic tanks have been used mainly in small installations, or, where employed in large installations, the form has been modified to secure digestion of the sludge in a separate compartment, thus in a measure obviating disadvantages that exist where septicization takes place in the presence of the entering fresh sewage.

Purposes.—The purposes of a septic tank are to receive all the farm sewage, as defined on page 4, hold it in a quiet state for a time, thus causing partial settlement of the solids, and by nature's processes of decomposition insure, as fully as may be, the destruction of the organic matter.

Limitations.—That a septic tank is a complete method of sewage treatment is a widespread but wrong impression. A septic tank does not eliminate odor and does not destroy all organic solids. On the contrary, foul odors develop, and of all the suspended matter in the sewage about one-third escapes with the effluent, about one-third remains in the tank, and about one-third only is destroyed or reduced to liquids and gases. The effluent is foul and dangerous. It may contain even more bacteria than the raw sewage, since the process involves intensive growths. As to the effects upon the growth and virulence of disease germs little is known definitely. It is not believed that such germs multiply under the conditions prevailing in a septic tank. If disease germs are present many of their number along with other bacteria may pass through with the flow or may be enmeshed in the settling solids and there survive a long time. Hence the farmer should safeguard wells and springs from the seepage or discharges from a septic tank as carefully as from those of liquefying closets and cesspools.

Further treatment of effluents.—The effluent of a septic tank or any other form of sewage tank is foul and dangerous. Whether or not the solids are removed by screening, by short periods of rest, as in plain or modified forms of settling tanks, or by longer quiescence, as in septic tanks, the effluent generally requires further treatment to reduce the number of harmful organisms and the liability of nuisance. This further treatment usually consists of some mode of filtration. In the earliest example of such treatment the sewage was used to irrigate land by either broad flooding or furrow irrigation. By another method the sewage is distributed underground by means of drain tile laid with open joints, as illustrated in figures 17, 29, and 32.

Artificial sewage filters are composed of coarse sand, screened gravel, broken stone, coke, or other material, and the sewage is applied in numerous ways. Since filtration is essentially an oxidizing process requiring air, the sewage is applied intermittently in doses.[9]

If properly designed and operated, filters of sand, coke, or stone are capable of excellent results. Under the most favorable conditions it is unwise to discharge the effluent of a sewage filter in the near vicinity of a source of water supply. Under farm conditions filters are usually neglected or the sewage is improperly applied, resulting in the clogging and befouling of sand filters and the discharge from stone filters of an effluent which is practically as dangerous and even more offensive than raw sewage. Moreover unless the filters are covered there are likely to be annoying odors, and there is always the possibility of disease germs being carried by flies where sewage is exposed in the vicinity of dwellings. Hence it seems more practical for the farmer, avoiding the expense of earth embankments or masonry sides and bottom for a filter bed, to waste the tank effluent beneath the surface of such area of land as is most suitable and available. This method of applying sewage to the soil or subsoil is often spoken of as subirrigation, but subsoil distribution of sewage is different in principle and practice from subirrigation for the increase of crop yields. Subirrigation is rarely successful unless the land is nearly level, the top soil porous and underlaid with an impervious stratum to hold the water within reach of plant roots, and unless a relatively large quantity of water is used and the work is skillfully done. On the other hand, the quantity of sewage on farms being small, it may be wasted in hilly ground, which should be as porous, deeply drained, and dry as possible.

Parts of a system.—The four parts of a septic-tank installation with subsurface distribution of the effluent are outlined in figure 19: (1) The house sewer from house to tank; (2) the sewage tank consisting of one or more chambers; (3) the sewer from tank to distribution field; (4) the distribution field, where the sewage is distributed and wasted, sometimes called the absorption field. These parts will be discussed in the order named, although the last should have the first consideration.

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[9] Artificial filters of various types are well described and illustrated in Public Health Bulletin No. 101, "Studies of Methods for the Treatment and Disposal of Sewage—The Treatment of Sewage from Single Houses and Small Communities." U. S. Public Health Service, December, 1919.

House sewer.—The length will vary with the slope of the ground and position of buildings, well, and distribution field. Fifty to 100 feet is a fair length; a greater is still more sanitary. Wherever possible the house sewer should be laid straight in line and grade. Figure 20 shows how this work may be done. Suppose the distance from A to E be 100 feet; that grade boards be set 25 feet apart crosswise of the trench at A, B, C, D, and E; that the ground at A be 4 feet lower than at E; that the top of the sewer be 2½ feet below the surface of the ground at A and 4½ feet below the surface of the ground at E; the fall of the sewer between A and E is 2 feet (4+2½−4½=2). If the fall in 100 feet be 2 feet, in 25 feet it is one-fourth as much, or 6 inches. Hence, grade board B is 6 inches higher than grade board A, C is 6 inches higher than B, and so on to E. The top edges when all the boards are set with a carpenter's level and fastened in position should be in line. The grade thus established may be any con-

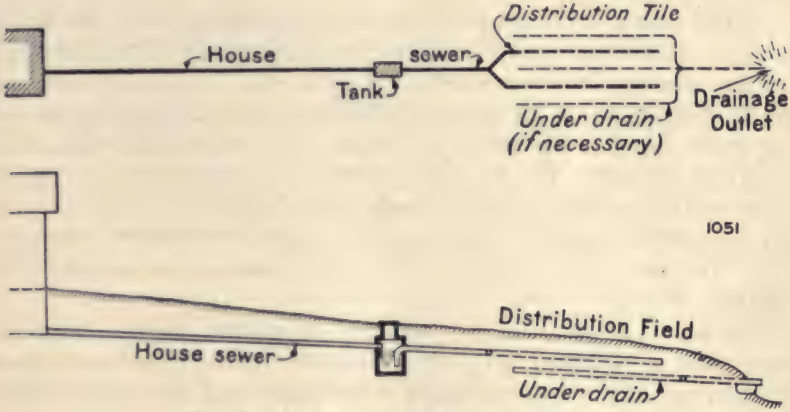


FIG. 19.—Parts of a septic-tank installation.

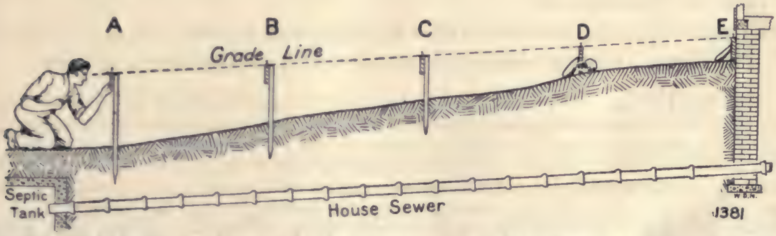


FIG. 20.—Setting line and grade for house sewer. To the observer at *A* the top edges of the grade boards appear as one; the half-driven nails are set to line.

venient height above the top of the proposed sewer, and the measuring stick used to grade the pipe is cut accordingly. This height is usually a certain number of whole feet. Fixing the line of the sewer is a mere matter of settling nails in the top edges of boards A and E directly over the center of the proposed sewer and tightly stretching a fish line or grade cord; nails should be set where the cord crosses boards B, C, and D.

If the cellar or basement contains plumbing fixtures, the house sewer should enter 1 to 2 feet below the cellar floor. If all plumbing fixtures are on the floors above, the sewer may enter at no greater depth than necessary to insure protection from frost outside the cellar wall. Digging the trench and laying the pipe should begin at the tank or lower end. The large end of the pipes, called the hub, should face uphill, and the barrel of each pipe should have even bearing throughout its length. Sufficient earth should be removed from beneath the hubs to permit the joints to be made in a workmanlike manner.

The house sewer may be vitrified salt-glazed sewer pipe, concrete pipe, or cast-iron soil pipe. The latter, with poured and calked lead joints makes a permanently water-tight and root-proof sewer, which always should be used where the vicinity of a well must be passed; 4, 5, or 6-inch pipe may be used, depending mainly on the fall and in less degree on the quantity of sewage discharged. As a measure of economy the 4-inch size is favored for iron pipe. If vitrified pipe is used, either the 5 or 6 inch size is preferable, as these sizes are made straighter than the 4-inch size and are less liable to obstruction. Of the two the 5-inch size is preferable. The fall in 100 feet should never be less than 2 feet for 4-inch size, 1½ feet for 5-inch size, 1 foot for 6-inch size.

Figure 21 shows methods of making good joints. *A*, *B*, *C*, *D*, *E*, *F*, and *G* are ordinary sewer pipe joints; *H*, is cast-iron soil pipe.

A shows the use of a yarning iron to pack a small strand of jute into the joint space, thus centering the pipes and preventing the joint filler running inside. The joint surfaces should be free of dirt and oil. The jute is cut in lengths to go around the pipe; a small strand is soaked in neat Portland cement grout, then twisted and wrapped around the small end of the pipe to be pushed into the hub of the last pipe laid. After the pipe is pushed home the jute is packed evenly to a depth of not over ½ inch, leaving about 1½ inches for the joint filler. Old hemp rope or oakum dipped in liquid cement or paper may be used in place of jute, and the packing may be done with a thin file or piece of wood.

B shows the use of a rubber mitten or glove to force Portland cement mortar into the joint space. The mortar should be thoroughly and freshly mixed in the proportion of one volume of cement to one volume of clean sand and should be pressed and tamped to fill the joint completely.

C shows a section of finished joint. The fresh mortar should not be loosened or disturbed when laying the next pipe.

D shows method of pouring a joint with grout, which is quicker, cheaper, and better than using a rubber mitten. A flexible sheet-metal form or mold, oiled to prevent the grout sticking, is clamped tightly around the joint and is completely filled with grout consisting of equal parts of Portland cement and clean sand mixed dry, to which water is added to produce a creamy consistency. The pipes should not be disturbed and the form should not be removed for 24 hours.

E shows a section of grouted joint, well rounded out, strong, and tight.

F shows the use of a pipe jointer for pouring a hot filler. The pipe jointer may be an asbestos or rubber runner or collar or a piece of garden hose clamped around the pipe leaving a small triangular opening at the top. The jointer is pressed firmly against the hub, and any small openings between the jointer and pipe are smeared with plastic clay to prevent leakage of the filler. A clay dike or funnel about 3 inches high built around the triangular opening greatly aids rapid and complete filling of the joint space. The filler may be a commercially prepared bituminous compound or molten sulphur and fine sand. The former makes a slightly elastic joint; the latter a hard unyielding joint. With good workmanship both kinds of joint are practically water-tight and root-proof, and cost about the same as cement mortar joints. The filler is heated in an iron kettle over a wood, coke, or coal fire. It should be well stirred, and when at a free running consistency should be poured with a ladle large enough to fill the joint completely at one operation. As soon as the compound cools the jointer is removed. Sulphur-sand filler is made by mixing together dry and melting equal volumes of ordinary powdered sulphur and very fine clean sand, preferably the finest quicksand. A 5-inch sewer pipe joint requires from three-tenths to nine-tenths of a pound (according to the kind of pipe) of sulphur, worth 3 to 5 cents per pound, and a like quantity of sand. From ½ to 1½ pounds of bituminous filler are required for a 5-inch pipe joint.

G shows section of finished joint.

H shows the use of a pouring ladle in making lead joints in cast-iron soil pipe. This pipe is in lengths to lay 5 feet, and the metal of the barrel is ¼ inch thick. The joint is yarned with dry jute or oakum, as described above, and is poured full with molten, soft, pig lead to be afterwards driven tightly with hammer and calking tools. About 1 pound of lead for each inch in diameter of pipe is required. Prepared cements of varying composition have proved effective and, as they require no calking, are economical. Among the best is a finely ground, thoroughly mixed compound of iron, sulphur, slag, and salt.

I is a homemade pipe jointer or clay roll for use in pouring molten lead. A strand of jute long enough to encircle the pipe and the ends to fold back, leaving an opening at the top, is covered with clay moistened, rolled, and worked to form a plastic rope about 1 inch in diameter. The jointer gives the very best results but must be frequently moistened and worked to keep the clay soft and pliable. The jointer shown in *F* is frequently used for pouring lead joints.

Obstructions in house sewers are frequent. Among the causes are broken pipes, grade insufficient to give cleansing velocities, newspaper, rags, garbage, or other solids in the sewage, congealing of grease in pipes and main running traps (house sewer traps), and poor joint construction whereby rootlets grow into the sewer and choke it. Good grade and good construction, with particular care given to the joints, will avert or lessen these troubles. The sewer should be perfectly straight, with the interior of the joints scraped or swabbed smooth. When the joint-filling material has set, the hollows beneath the hubs should be filled with good earth free of stones, well tamped or puddled in place. It is important that like material be used at the sides of the pipe and above it for at least 1 foot. The back filling may be completed with scraper or plow. No running trap should be placed on the house sewer, because it is liable to become obstructed and it prevents free movement of air through the sewer and soil stack. Conductors or drains for rain or other clean water should never connect with the house sewer, but should discharge into a watercourse or other outlet.

Where obstruction of a house sewer occurs, use of some of the simple tools shown in figure 22 may remedy the trouble. It is not likely that farmers will have these appliances, except possibly some of the augers; but some of them can be made at home or by a blacksmith, and most of them should be obtainable for temporary use from a well-organized town or city sewer department. The purpose of the several tools shown is indicated in the notation.

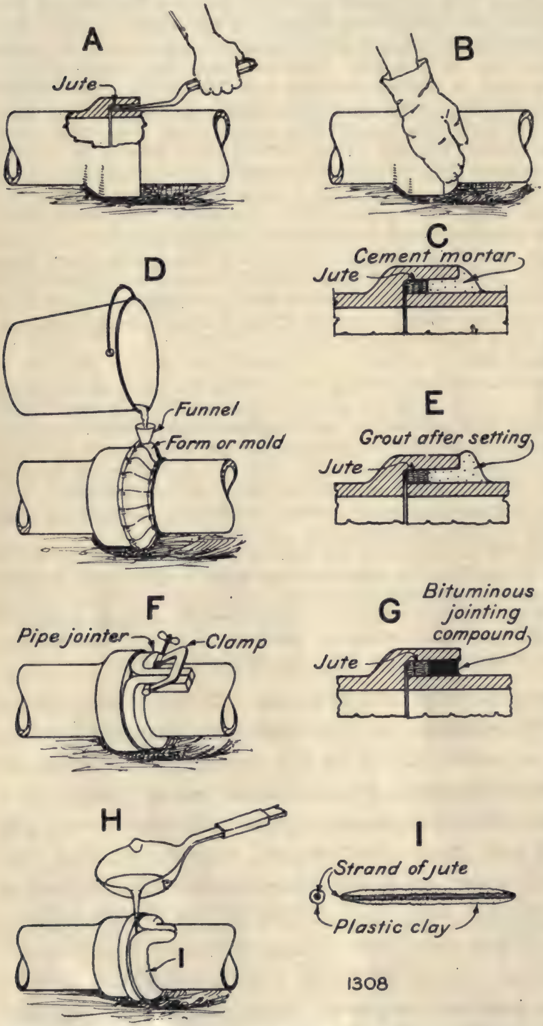


FIG. 21.—How to make good joints. See text for directions and specifications.

The tank.—The septic tank should be in an isolated location at least 50 to 100 feet from any dwelling. This is not always possible, because of flat ground, but in many such instances reasonable distance and fall may be secured by raising both the house sewer and tank and embanking them with earth. Cases are known where tanks adjoin cellar or basement walls and the top of the tank is used as a doorstep; in other cases tanks have been constructed within buildings. Such practices are bad. It is difficulty to construct an absolutely water-tight masonry tank, and still more difficult to make it proof against the passage of sewage odors.

In Northern States, particularly in exposed situations, it is desirable to have the top of the tank 1 to 2 feet underground, thus promoting warmth and uniformity of temperature in the sewage.

In Southern States this feature is less important, and the top of the tank may be flush with the ground. Every tank should be tightly covered, for the reason above stated and to guard against the spread of odors, the transmission of disease germs by flies, and accidents to children.

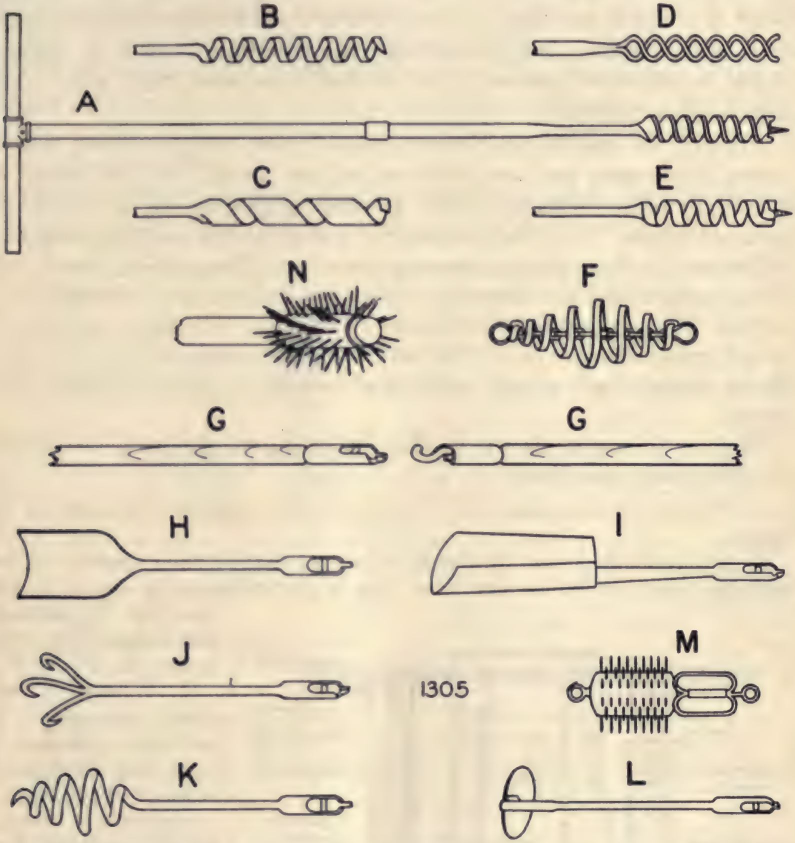


FIG. 22.—Sewer-cleaning tools—how to use them. *A*, Ordinary 1½ or 2 inch auger welded to a piece of ¾-inch extra-strong wrought pipe about 5 feet long; the stem is lengthened by adding other pieces of pipe with screw couplings, and is fitted with a pipe handle; all cleaning work should proceed upstream; *B*, twist or open earth auger; *C*, ribbon or closed earth auger; *D*, spiral or coal auger; *E*, ship auger; *F*, root cutter; *G*, sewer rods with hook coupling, usually of hickory or ash 1 or 1¼ inches in diameter and 3 or 4 feet long; *H*, gouge for cutting obstructions; *I*, scoop for removing sand or similar material; *J*, claw, and *K*, screw, for removing paper or rags; *L*, scraper; *M*, wire brush for removing grease, drawn back and forth with a wire or rope; *N*, home-made wire brush (for a 5-inch sewer use a 1½-inch wooden pole to which is securely tacked a piece of heavy rubber, canvas or leather belting or harness leather 5½ by 8 inches, spirally studded, as shown, with ordinary wire nails 1½ inches in length).

Considerable latitude is allowable in the design and construction of septic tanks. No particular shape or exact dimensions can be presented for a given number of people. One family of 5 persons may use as much water as another family of 10 persons; hence the quantity of sewage rather than the number of persons is the better basis of design. Exact dimensions are not requisite, for settlement and septicization proceed whether the sewage is held a few hours more or a few hours less. As to materials of construction some form of masonry, either brick, building tile, rubble, concrete, or cement block, is employed generally. Vitrified pipe, steel, and wood have been used occasionally.

A plant for use all year round should have two chambers, one to secure settlement and septicization of the solids and the other to secure periodic discharge of the effluent by the use of an automatic sewage siphon. The first chamber is known as the settling chamber, the second as the siphon or dosing chamber. The siphon chamber is often omitted and the effluent is allowed to dribble away through subsurface tile, as illustrated in figures 17 and 18. The latter procedure is not generally advised, but may be permissible where the land slopes sharply or has long periods of rest, as at summer houses and camps.

The septic tanks shown in this bulletin are designed to satisfy the following conditions:

1. Water consumption of 40 gallons per person per day of 24 hours.

2. A detention period of about 24 hours; that is, the capacity of the settling chamber below the flow line is approximately equal to the quanity of sewage discharged from the house in 24 hours.

3. Where a siphon chamber is provided, its size is such that the dose of sewage shall be approximately equal to 20 gallons per person; that is, the capacity of the siphon chamber between the discharge and low-water lines is roughly equal to the quantity of sewage discharged in 12 hours.

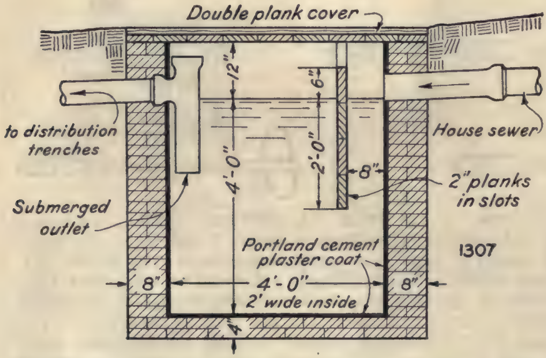


FIG. 23.—One-chamber septic tank—does nothing more than a tight cesspool. Brick construction, heavily plastered inside; size suitable for 180 to 280 gallons of sewage daily (nominally 4 to 7 persons).

A simple one-chamber brick tank suitable for a household discharging 180 to 280 gallons of sewage daily is shown in figure 23. A small two-chamber tank constructed of 24-inch vitrified pipe, suitable for a household discharging about 125 gallons of sewage daily, is shown in figure 24. A typical two-chamber concrete tank is shown in figure 25. Excepting the submerged outlet, all pipes within the tank and built into the masonry are cast-iron soil pipe with cast-iron fittings. Vitrified or concrete sewer pipe and specials are generally used as they are frequently more readily obtainable and a slight saving in first cost may be effected. Cast iron is less liable to be broken in handling or after being set rigidly in masonry, and the joints are more easily made water-tight. The submerged outlet is midway of the depth of liquid in the settling chamber. The inside depth of the siphon chamber is the drawing depth of the siphon plus 1 foot 5 inches.

The following table gives the principal dimensions with quantities of materials for four sizes of tank as illustrated in figure 25:

Dimensions and quantities for septic tanks.

Number of persons.	Quantity of sewage in 24 hours.	Settling chamber.											
		Capacity below flow line.	Length.		Depth.		Width.		W.	X.		Y.	Z.
	Galls.	*Galls.*	*Ft.*	*In.*	*Ft.*	*In.*	*Ft.*	*In.*	*In.*	*Ft.*	*In.*	*In.*	*In.*
5	180-280	240	4	0	5	0	2	0	6	2	0	4	6
10	320-480	420	5	0	5	6	2	6	6	2	3	4	6
15	520-680	620	5	6	6	0	3	0	8	2	6	5	8
20	720-960	860	6	0	6	6	3	6	8	2	9	5	8

Number of persons.	Quantity of sewage in 24 hours.	Siphon chamber.										Concrete.	Cement.	Sand.	Stone.	Reinforcement in top slab (strip of heavy stock fencing).	
		Length.		Depth.		Width.		A.	B.	C.	D.					Length.	Width.
	Galls.	*Ft.*	*In.*	*Ft.*	*In.*	*Ft.*	*In.*	*In.*	*In.*	*In.*	*In.*	*Cu. yds.*	*Bbls.*	*Cu. yds.*	*Cu. yds.*	*Ft.*	*In.*
5	180-280	5	0	2	8	2	0	3	4	15	18¼	3	4½	1⅓	2⅔	10	3
10	320-480	8	0	2	8	2	6	3	4	15	18¼	4¼	6¼	2	3¾	14	3
15	520-680	8	8	2	10	3	0	4	4	17	20¼	6⅔	9¾	3	6	15¾	4
20	720-960	10	0	2	10	3	6	4	4	17	20¼	8	12	3½	7	17½	5

Siphons.—Reference has already been made to the vital importance of air in sewage filtration. If the spaces within a filter or soil are constantly filled with water, air is excluded, and the action of the filtering material is merely that of a mechanical strainer with its clogging tendency. The purpose of a siphon is twofold: (1) To secure intermittent discharge, thus allowing a considerable period of time for one dose to work off in the soil and for air to enter the soil spaces before another flush is received; (2) to secure distribution over a larger area and in a more even manner than where the sewage is allowed to dribble and produce the conditions of the old-fashioned sink drain—namely, a small area of water-logged ground.

Three types of sewage siphon are shown in figure 26. In all, the essential principle is the same: A column of air is entrapped between two columns of water; when the water in the chamber rises to a predetermined height, called the discharge line, the pressure forces

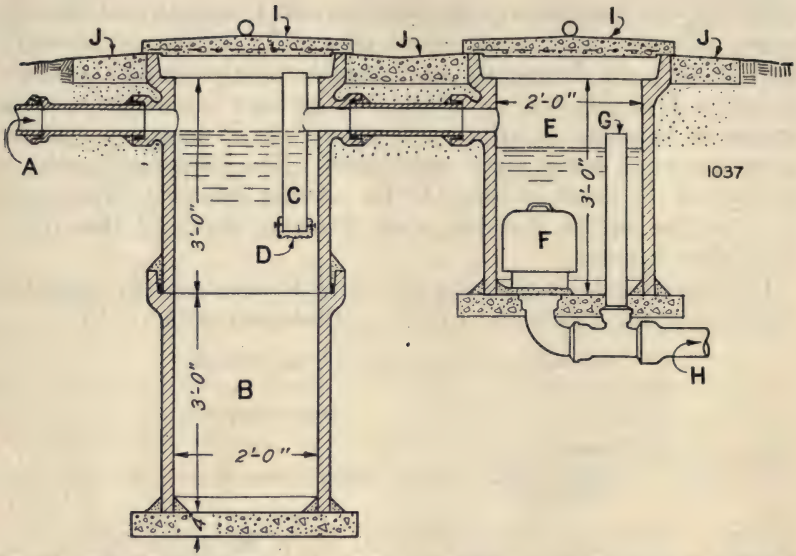


FIG. 24.—Two-chamber septic tank, simple and inexpensive. Constructed of 24-inch vitrified sewer pipe; size suitable for 125 gallons of sewage daily (nominally 3 persons). *A*, House sewer; *B*, settling chamber, made of one double T branch and one length of straight pipe, each 3 feet long and 2 feet in diameter, supported by 4 inches of concrete, all joints made water-tight; *C*, submerged outlet, consisting of a metal T slipped into the sewer-pipe branch; *D*, wire screen, ¼-inch mesh; *E*, siphon chamber made of one T branch 3 feet lòng and 2 feet in diameter; *F*, siphon; *G*, 3-inch overflow; *H*, sewer to distribution field; *I*, tightcover with lifting ring; *J*, concrete protection around sewer-pipe hubs.

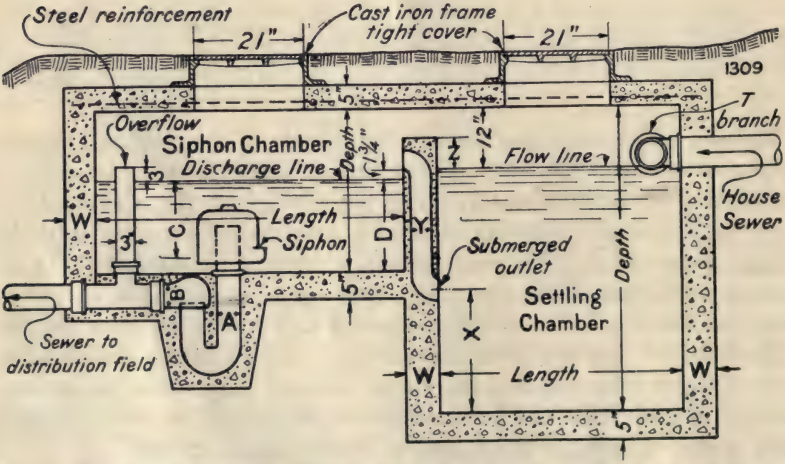
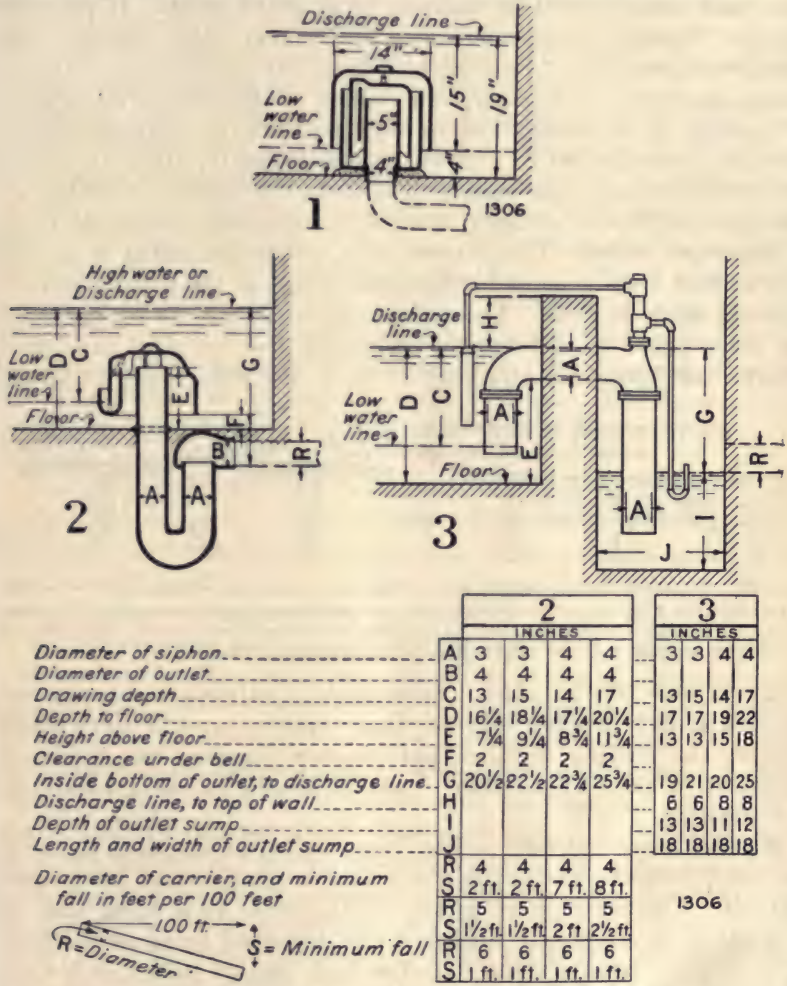


FIG. 25.—Typical two-chamber concrete septic tank. (See table for dimensions and quantities for different sizes.)

out the confined air, destroying the balance and causing a rush of water through the siphon to the sewer. The entire operation is automatic and very simple. The siphons shown are commercial products made of cast iron; they have few parts and none that move, and the whole construction is simple and durable. The table (fig. 26) lists stock sizes adapted to farm use. Manufacturers furnish full information for setting their siphons and putting them in operation. For example, take type 2, figure 26: (1) Set siphon trap (U-shaped pipe) plumb, making E (height from floor to top of long leg) as specified;



		2				3			
		INCHES				INCHES			
Diameter of siphon	A	3	3	4	4	3	3	4	4
Diameter of outlet	B	4	4	4	4				
Drawing depth	C	13	15	14	17	13	15	14	17
Depth to floor	D	16¼	18¼	17¼	20¼	17	17	19	22
Height above floor	E	7¼	9¼	8¾	11¾	13	13	15	18
Clearance under bell	F	2	2	2	2				
Inside bottom of outlet, to discharge line	G	20½	22½	22¾	25¾	19	21	20	25
Discharge line, to top of wall	H					6	6	8	8
Depth of outlet sump	I					13	13	11	12
Length and width of outlet sump	J					18	18	18	18
Diameter of carrier, and minimum fall in feet per 100 feet	R	4	4	4	4				
	S	2 ft.	2 ft.	7 ft.	8 ft.				
	R	5	5	5	5				
	S	1½ ft.	1½ ft.	2 ft	2½ ft.				
	R	6	6	6	6				
	S	1 ft.	1 ft.	1 ft.	1 ft.				

FIG. 26.—Three types of sewage siphon. The table gives dimensions for setting standard 3 and 4 inch siphons; also the appropriate size and grade of the sewer to carry the siphon discharge.

(2) fill siphon trap with water till it begins to run out at B; (3) place bell in position on top of long leg, and the siphon is ready for service. Do not fill vent pipe on side of bell.

The overhead siphon, type 3, figure 26, may be installed readily in a tank already built by addition of an outlet sump. If properly set and handled, sewage siphons require very little attention and flush with certainty. Like all plumbing fixtures they are liable to stoppage if rags, newspaper, and similar solids get into the sewage. If fouling of the sniffing hole or vent prevents the entrance of sufficient air into the bell to lock the siphon properly, allowing sewage to dribble through, the remedy is to clean the siphon. Siphons are for handling liquid; sludge if allowed to accumulate will choke them.

Submerged outlet.—The purpose of a submerged outlet is to take the outflow from a point between the sludge at the bottom and the floating solids or scum. The outlet in figure 25 may be readily made of sheet metal by a tinsmith. Wrought iron or steel pipe with elbows or light lead pipe may be used, the pipe being set in the concrete and left in place. Sometimes a galvanized wire screen (¼-inch mesh) is fitted over the inner end to prevent large solids leaving the settling chamber and possibly clogging the siphon or distribution tile. If a screen is used it should be easily removable for cleaning.

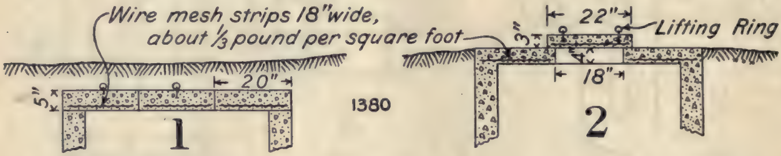


FIG. 27.—Homemade reinforced concrete covers. (1) Slabs placed crosswise permit uncovering the whole tank for cleaning, but as inspection is somewhat difficult, cleaning is the more likely to be neglected; (2) manhole, 18 inches square; cover, 22 by 22 by 3 inches thick, easy to make and to slide or lift from the opening.

Manhole frame and cover.—The frame and cover shown in figure 25 are stock patterns made of cast iron and weighing about 250 pounds per set. The cover is 21 inches in diameter; it is tight and, on account of its weight, is unlikely to be disturbed by small children. The frame or rim is about 7 inches high and 31 inches in longest diameter. If desired, light cast-iron cistern or cesspool covers obtainable from plumbing supply houses, home-made slabs of reinforced concrete (see fig. 27), or wooden covers (see fig. 23) may be used.

Overflow.—The purpose of an overflow is to pass sewage to the distribution field should the siphon stop working. The overflow (fig. 25) is a 3-inch riser pipe with top 3 inches above the discharge line and the bottom calked or cemented into the side outlet of a T-branch. The run of the T-branch should correspond with the size of the sewer from the tank to the distribution field. If this sewer is 4-inch pipe, a 4 by 3 inch T-branch is used, the 4-inch spigot end of the siphon being calked or cemented into the branch, as shown in figure 25; if the sewer is 5-inch, a 5 by 3 inch T-branch is used and connected to the siphon with a 5-inch to 4-inch reducer (in vitrified specials the equivalent is a 4-inch to 5-inch increaser); if the sewer is 6-inch, a 6 by 3 inch T-branch is used and connected to the siphon with a 6-inch to 4-inch reducer.

Concrete work.—Before excavation for the tank is begun, two wooden forms should be built for shaping the inside of the settling and siphon chambers. In most instances the ground is fairly firm, so that the lines of excavation may conform to the outside dimensions of the tank, the back of the walls being built against the earth. The forms may be made of square-edged boards, braced and lightly nailed, as shown in figure 28. The forms should have no bottom. If it is desired to lay the sides and covering slab in one operation, the top of the forms must be boarded over. All pipe and manhole openings should be accurately placed and cut. The faces of the forms may be covered with paper or smeared with soap or grease to facilitate removal later.

The ground should next be excavated to the proper depth for placing the floors in both chambers. The settling chamber floor, being the lower, should be placed first. Effort should be made to secure water-tight work, a feature of especial importance where leakage might endanger a well or spring. A concrete mixture of 1:2:4 is generally preferred (1 volume cement, 2 volumes sand, 4 volumes stone). The ingredients should be of best quality and thoroughly mixed. The concrete should be poured promptly and worked with a spade or flat shovel to make the face smooth and eliminate pockets or voids within the mass.[10] Before the settling chamber floor has hardened the form should be set upon the floor and the concrete work continued up the sides. The pipe form for the submerged outlet should be set. When the side walls of the settling chamber have reached the bottom of the excavation for the siphon chamber, the siphon trap with its connecting branch and short piece of pipe should be set to proper line and grade and blocked in position. The floor of the siphon chamber should now be poured and the form for that chamber placed thereon, leaving a 6-inch or 8-inch space (according to the thickness of the division wall) between the ends of the two forms. Pouring of all side walls and the top slab should continue without stop, making the entire structure a monolith.

Steel reinforcement.—To stiffen the cover slab and guard against cracking, a little steel should be embedded in the concrete about 1 inch above the inside top. For this purpose a strip of heavy stock fencing is convenient and inexpensive. The line wires should be not less than No. 10 gauge (about $\frac{1}{8}$ inch) and the stay wires not less than No. 11 gauge. The reinforcement should be cut at manholes and

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[10] See footnote, p. 17. For more detailed information on form and concrete work the reader is referred to U. S. Department of Agriculture Farmers' Bulletin No. 481, "Concrete Construction on the Live-Stock Farm."

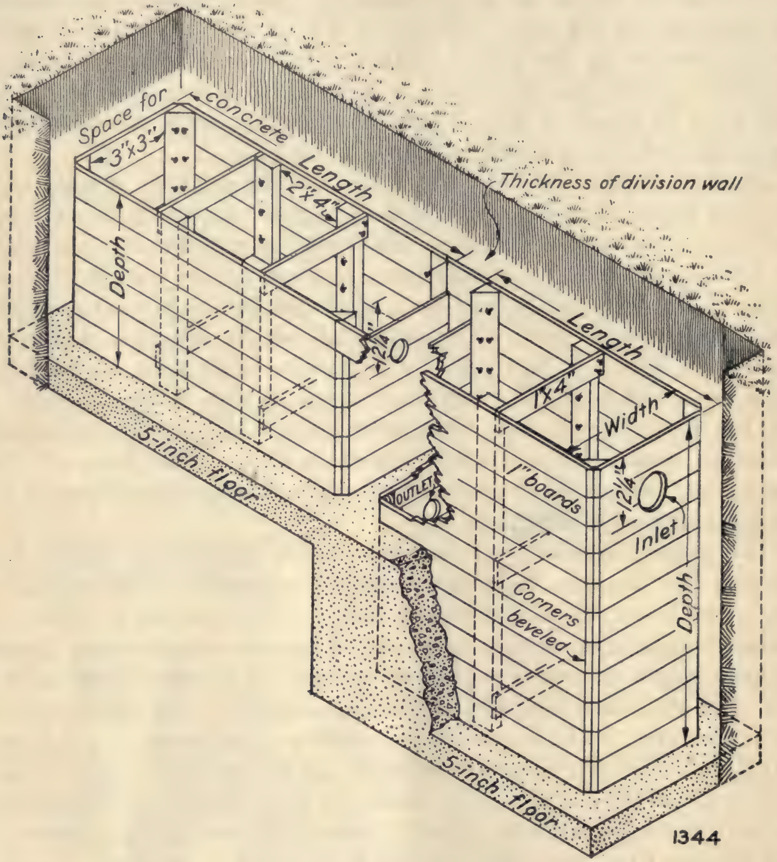


FIG. 28.—Forms for concrete work—how to use them.

1. Make the forms as shown and to the dimensions required by fig. 25 and the table on p. 37; nails to be driven from the inside and left projecting for drawing with a claw hammer.
2. Excavate to lines 6 or 8 inches, as may be required, outside of the forms and to the depths required for both chambers.
3. Pour settling chamber floor and place form thereon.
4. Pour settling chamber walls to level of siphon chamber excavation, inserting submerged outlet pipe at the proper height.
5. Block siphon trap and connected branch and short pipes to correct line and grade, and fill with concrete around the trap.
6. Pour siphon chamber floor, and place the form thereon.
7. Continue pouring all walls to their full height, inserting the inlet pipe when the concrete reaches that elevation.
8. Do not remove forms till the concrete is hard; with favorable weather, forms for walls only may be removed in 1 to 2 days; forms supporting a cover slab should remain 1 to 2 weeks.

fastened around manhole openings. If desired a standard wire-mesh reinforcement weighing about one-third of a pound per square foot may be used. Another alternative is to use ¼-inch round rods, spacing the crosswise rods 6 inches apart and the lengthwise rods 12 inches apart. Poultry netting should not be used, because of its lightness.

Sewer from tank to distribution field.—The length of this sewer depends on the situation of the field and the fall to it. The size of the sewer depends on the fall that can be obtained and the size of siphon. The table in figure 26 shows the minimum fall at which 4-inch, 5-inch, and 6-inch sewers should be laid to take the discharge of the 3-inch and 4-inch siphons specified. The line and grade should be set in the same manner as for the house sewer (see fig. 20), and the construction should be as specified under that caption.

Distribution field.—The distribution field or area is a sewage filter, and its selection and the manner of preparing it largely determine the success of subsoil disposal of sewage. As a rule farm land is not the best filtering material. It is too fine grained and fertile. Its tendency is to hold water too long, to admit insufficient air, to clog when even small quantities of sewage are applied. Hence the distribution area should be of liberal size—on the average 500 square feet for each person served. It should be dry, porous, and well drained—qualities that characterize sandy, gravelly, and light loam soils. It should be devoid of trees and shrubbery, thus giving sunlight and air free access. It should be located at least 300 feet downhill from a well or spring used for domestic water supply. Preferably it should slope gently, but sharp slopes are not prohibitive. Subsoiling the area is always desirable.

Clay and other compact, impervious soils require special treatment. Less sewage can be applied to them, and hence it is well to have the area larger than 500 square feet per person. Clay should be subsoiled as deep as possible with a subsoil plow. In some instances dynamite has been of service in opening up the ground to still greater depth. Drainage and aeration should be further promoted by laying tile underdrains, as outlined in figure 19 and shown in more detail in figure 31.

After the construction work the distribution area should be raked and seeded with thick-growing grass. Grass is a safe crop; its water requirement is high, and it affords considerable protection from frost. Suitable grasses are redtop, white clover, blue grass, and Bermuda grass. The area may be pastured or kept as grass land.

Distribution system.—Poor distribution of the sewage and failure to protect the joints of the distribution tile account for most of the failures. Each flush of the siphon should be so controlled that every part of the field will receive its due proportion. The distribution tile must be so laid that loose dirt will not fall or wash into the open joints.

Different methods of dividing the flush and laying out the distribution tile are shown in figures 29 and 32. Layouts 1, 2, and 3, figure 29, are suitable for flat or gently sloping areas and are planned for the shallow siphon chambers tabulated on page 37. Layout 4, figure 29, is suitable for steep slopes. In all four layouts use is made of one or more V-branches (not Y-branches) to divide the flow equally among the several lines. V-branches, sometimes called breeches, should be leveled with a carpenter's level crosswise the ends of the legs, thus insuring equal division of the flow.

The size and length of distribution tile and the spacing of the lines or runs admit of considerable variation in different soils. Water sinks rapidly in gravels and sands, and hence larger tile and shorter length are permissible than in close soils. Lateral movement is slow in all soils, but extends farther in gravels and sands than in close soils. In average soils the effect on vegetation 5 feet away from the line is practically nil.

From these considerations, with the siphon dose 20 gallons per person, it is usually a safe rule to provide 50 feet of 3-inch tile for each person served and to lay the lines 10 feet apart. Such provision gives a capacity within the bore of the tile lines about equal to the siphon dose, and as some sewage is wasted at each joint a reasonable factor of safety is provided. A spacing of 10 feet will, it is believed, permanently prevent the extension of lateral absorption from line to line, provided the area is fairly well drained. As between 3-inch and 4-inch tile the smaller size costs less and is better calculated to taper the dose to small proportions. Four-inch tile is less likely to get out of alignment or to become clogged; a length of 28 feet has the same capacity in the bore as 50 feet of 3-inch.

Good-quality drain tile in 1-foot lengths or second-quality sewer pipe in 2-foot lengths may be used. The lines are generally laid in parallel runs, but may be varied according to the topography. Layouts 1, 2, and 3, figure 29, for flat or gently sloping land, run with the slope; layout 4, for steep slopes, runs back and forth along the contour in a series of long flat sweeps and short steep curves. The grade of the runs and sweeps should be gentle, rarely more than 10 or 12 inches in 100 feet. In layouts 1, 2, and 3, figure 29 especially, it is desirable that the last 20 feet of each run should be laid level or given a slight upward slope, thus guarding against undue flow of sewage to the lowest ends of the system.

The runs should be laid no deeper than necessary to give clearance when plowing and prevent injury from frost. Ten inches of earth above the top of the tile is sufficient generally throughout the south-

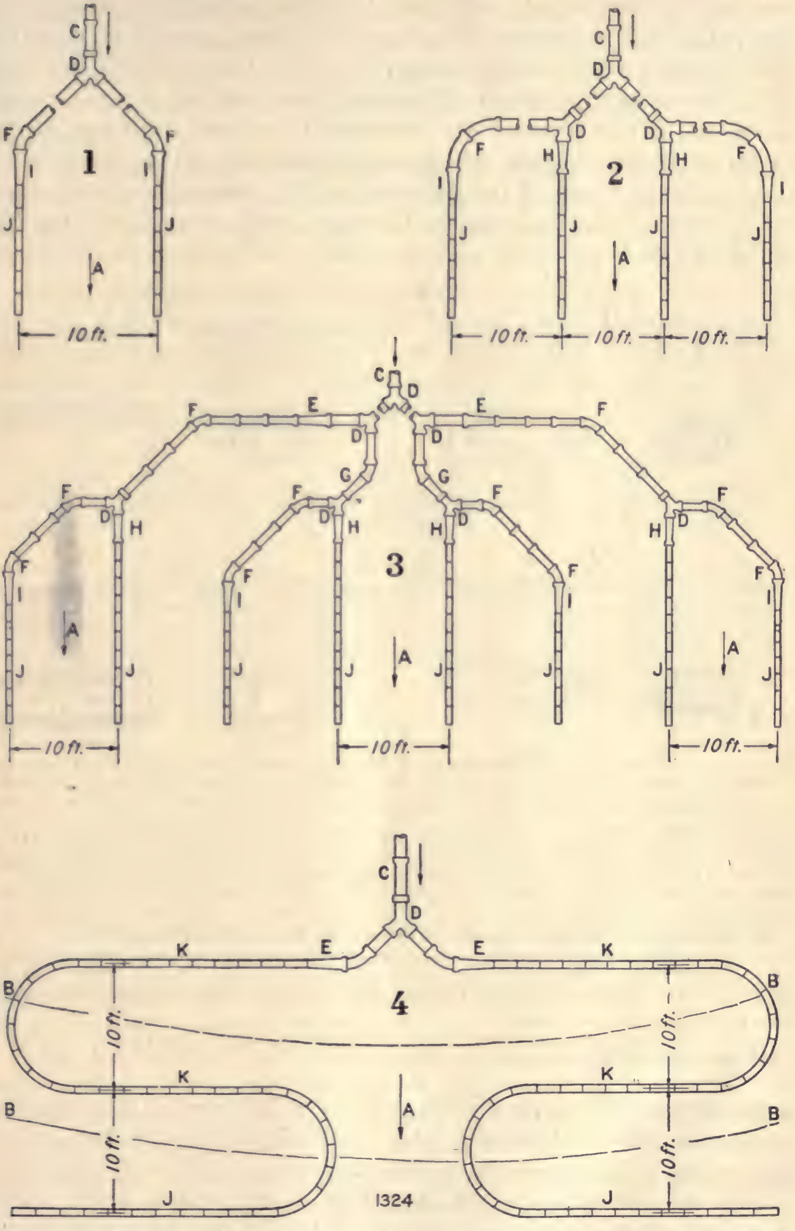


Fig. 29.—Methods of laying distribution system: Methods 1, 2, and 3 for flat or gently sloping land; method 4 for steep slopes (see also fig. 32); *A*, direction of slope; *B*, contour of field; *C*, sewer from tank, preferably size 5 inch, though 4 or 6 inch may be used, depending on the fall and the size of the siphon (see table, fig. 26); *D*, V-branch set to divide the flow exactly; *E*, reducer, to 4 inches; *F*, ⅛ bend, 4-inch; *G*, increaser, from 4 inches; *H*, increaser, 3 to 4 inches; *I*, reducer, 4 to 3 inches; *J*, distribution tile, 3-inch; *K*, distribution tile, 4-inch.

ern half of the United States and 18 inches generally in the North, but if the field is exposed or lacks a thick heavy growth of grass the cover should be increased to 2½ or 3 feet near the Canadian line. What is better, the tile in all instances may be laid with a 10-inch cover and in cold weather the runs may be covered with hay, straw, or leaves weighted down, which may be removed in the spring.

Making the joints of the distribution tile demands especial attention. For a short distance on the upper end of each run the tile should be laid with ends abutting; the joint opening should be increased gradually to one-eighth inch and this increased to one-fourth in the last 20 feet of the run. All joints should be protected against the entrance of loose dirt. Four methods are shown in figure 30. The lower end of each run should be closed with a brick or flat stone; or, what is better, an elbow or T-branch may be placed on the end and vented above the surface of the ground, improving the flow of sewage, the ventilation of pipes, and the aeration of the soil.

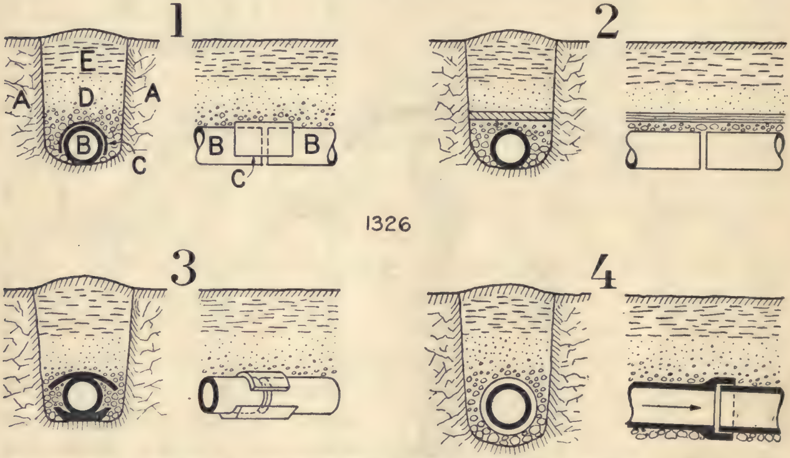


FIG. 30.—Four methods of protecting open joints in distribution lines—an all-important work. Sketches show cross-section and longitudinal views; the depth from the surface of the ground to the top of the tile is about 10 inches.

1. *A,* Subsoil ground; *B,* 3 or 4 inch drain tile; *C,* strip of tarred paper about 6 inches wide and extending three-fourths the distance around the tile, allowing sewage to escape at the bottom; *D,* coarse sand, gravel, broken stone or brick, slag, cinders, or coke, the coarsest material placed around the tile (where the ground is naturally very porous and well drained, special filling in the trench may be omitted); *E,* natural soil.

2. Drain tile covered with a board laid flat, leaving the entire joint open.

3. Drain tile laid in stoneware gutter pieces and the joint covered with stoneware caps; gutter and cap pieces are inexpensive commercial products; their radius is longer than that of the outside of the tile, thus leaving open most of the joint space; the gutter aids in keeping the tile in line.

4. Vitrified sewer pipe with hubs facing downhill; the spigot end should be centered in the hub with a few small chinks or wedges.

If the distribution tile must be laid in clay or other close, poorly drained soil, special treatment is necessary. A common method is to subsoil and underdrain the area thoroughly, as shown in figure 31. It is not always possible to run the underdrain in lines between the distribution lines as shown in figures 19 and 31, but it is a desirable thing to do, as the sewage must then receive some filtration through natural soil.

In some instances it is sufficient to lay the distribution tile on a continuous bed, 8 to 12 inches thick, of coarse gravel, broken stone, or brick, slag, coke, or cinders and complete the refill as shown in figure 18 or 31.

Figure 32 shows two other methods of controlling the flow on steep slopes and diverting proper proportions to the several lateral distributors laid along the contour of the field. This work can not be effected properly with T or Y branches; the flow tends to shoot straight ahead, comparatively little escaping laterally. To overcome this difficulty recourse is had to diverting boxes, of which two types are shown in figure 32. These boxes involve expense, but permit inspection and division of the flow according to the needs. They may be built of brick, stone, concrete, or even wood.

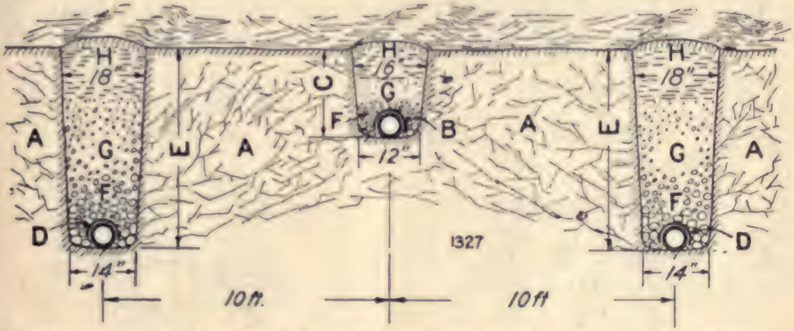


FIG. 31.—Close soils should be deeply subsoiled and underdrained. Porous, well-drained, air-filled soil is absolutely necessary. *A*, Subsoiled ground; *B*, 3 or 4 inch distribution tile; *C*, depth variable with the climate, 1½ to 3½ feet; *D*, 4-inch underdrain; *E*, depth such as would prepare land for good crop production, generally 3½ to 4 feet; *F*, stone or other coarse material; *G*, gravel grading upward to coarse sand; *H*, loose soil.

Type 1 consists of a single box, into which all the lateral distributors head. It will be noted that the laterals enter at slightly different elevations, the two opposite the inlet sewer being the highest, the next two slightly lower, and the next two the lowest. This staggering of the outlets, in a measure, offsets the tendency of the flow to shoot across and escape by the most direct route.

Type 2 calls for one or more diverting boxes, according to the number of lateral distributors, and readily permits of wasting sewage at widely separated elevations and distances. The outlet pipes enter the box at slightly different elevations, for the reason already stated. With either type, should the outlets not be set at the right elevations, partial plugging of the holes and a little experimenting will enable one to equalize or proportion the discharges.

Sewage switch.—The clogging of filters and soils after long-continued application of sewage has been previously referred to. It is, therefore, desirable to arrange the distribution system in two units with a switch between them, so that one area may drain and become aerated while the other is in use. This procedure is especially desirable where the soil is close and the installation of considerable size. It adds to the life and effectiveness of the distribution area and permits use of a plant in case it is necessary to repair, extend, or relay the tile in either unit.

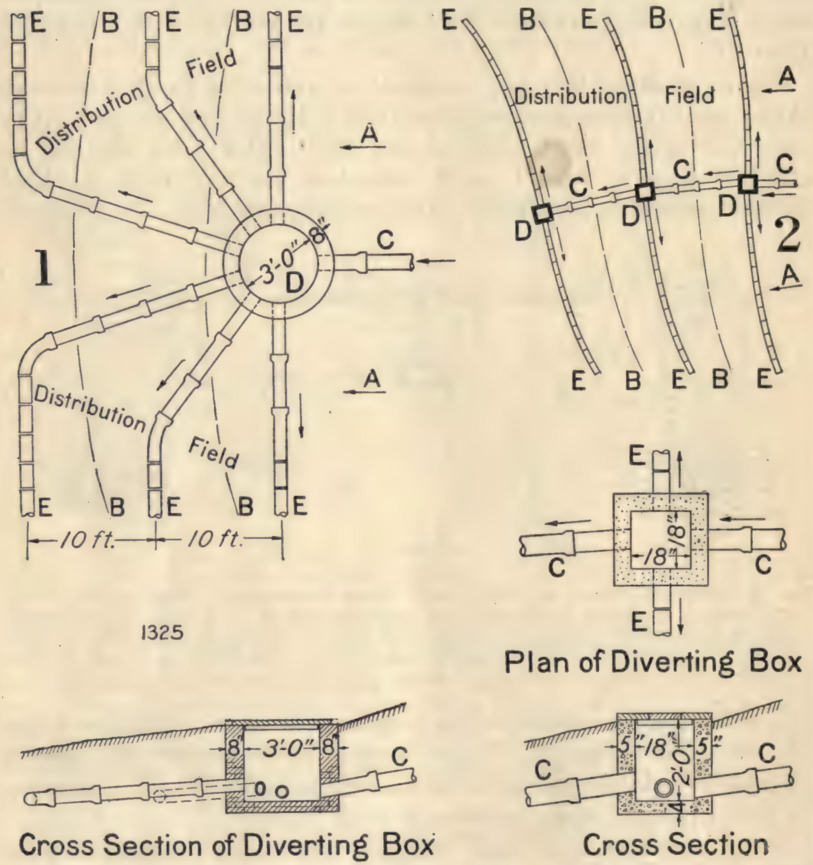


FIG. 32.—Two systems of distribution on steep slopes—use of diverting box. *A,* Direction of slope; *B,* contour of field; *C,* 4, 5 or 6 inch sewer from tank; *D,* diverting box; *E,* 3-inch or 4-inch distribution tile.

Arrangement in two units does not necessarily mean doubling the amount of tile and the area required in a single field. However desirable that may be, expense or lack of suitable ground will often prevent. With open sands and gravels and the assumed siphon dose of 20 gallons per person, 15 to 20 feet of 4-inch tile in each unit for each person will usually suffice. With more compact soil it is advisable to more nearly double the requirements previously described. Two simple types of switch are shown in figure 33. The switch should be turned frequently, certainly as often as is necessary to prevent saturation or bogginess of either area.

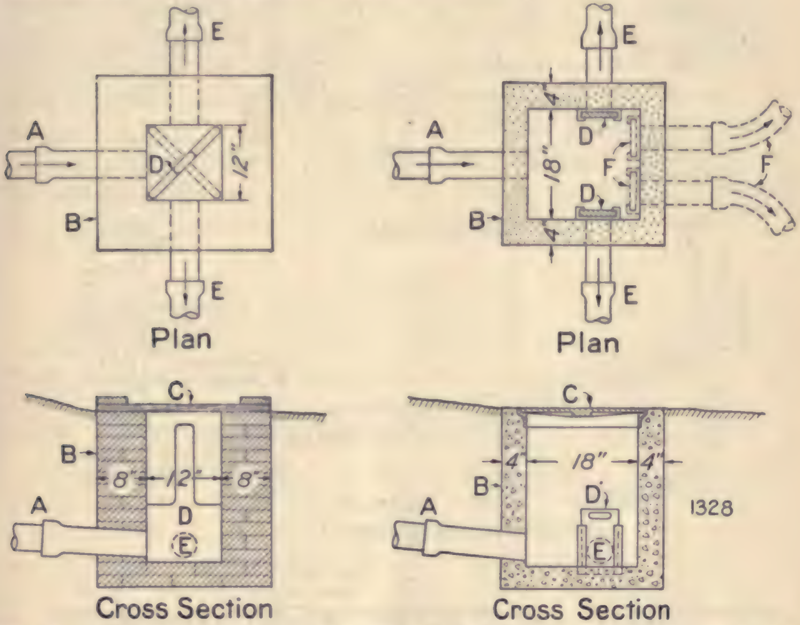


FIG. 33.—Two simple types of sewage switch. *A*, Sewer from tank; *B*, switch box; *C*, cover; *D*, blade or stop board (in the left-hand box the direction of flow is controlled by placing the blade in alternate diagonal position; in the right-hand box the stop works in iron guides cast integral with a short piece of light-weight pipe set in the masonry; if desired the guides may be wood, fastened to the masonry with expansion bolts); *E*, sewer to distribution area; *F* (right-hand box), alternate position of outlets or additional outlets if required.

A complete installation.—The general layout and working plans of a complete installation built in 1915–16 are shown in figure 34. The plant is larger than those heretofore considered, and involves several additional features. The settling chamber below the flow line has a capacity of 1,000 gallons, and on a basis of 40 gallons per person per day would serve 25 people.

For many years sewage had been discharged through two 4-inch sewers to a cesspool in the rear of the house. The proximity of the well made it unsafe, and the overflow of the cesspool dribbled over the low portion of the garden and barnyard, creating nuisance.

The first step was to make borings with a soil auger in the pasture 400 or 500 feet from the house. The borings showed a heavy clay soil to a depth of about 4 feet, underlaid with a sandy stratum only a few inches in thickness. It was decided to locate the distribution area in the pasture and to aid the seepage of sewage by digging numerous filter wells through the clay to the sandy stratum. Levels were taken and a contour plan prepared to serve for laying out the plant and establishing the grades.

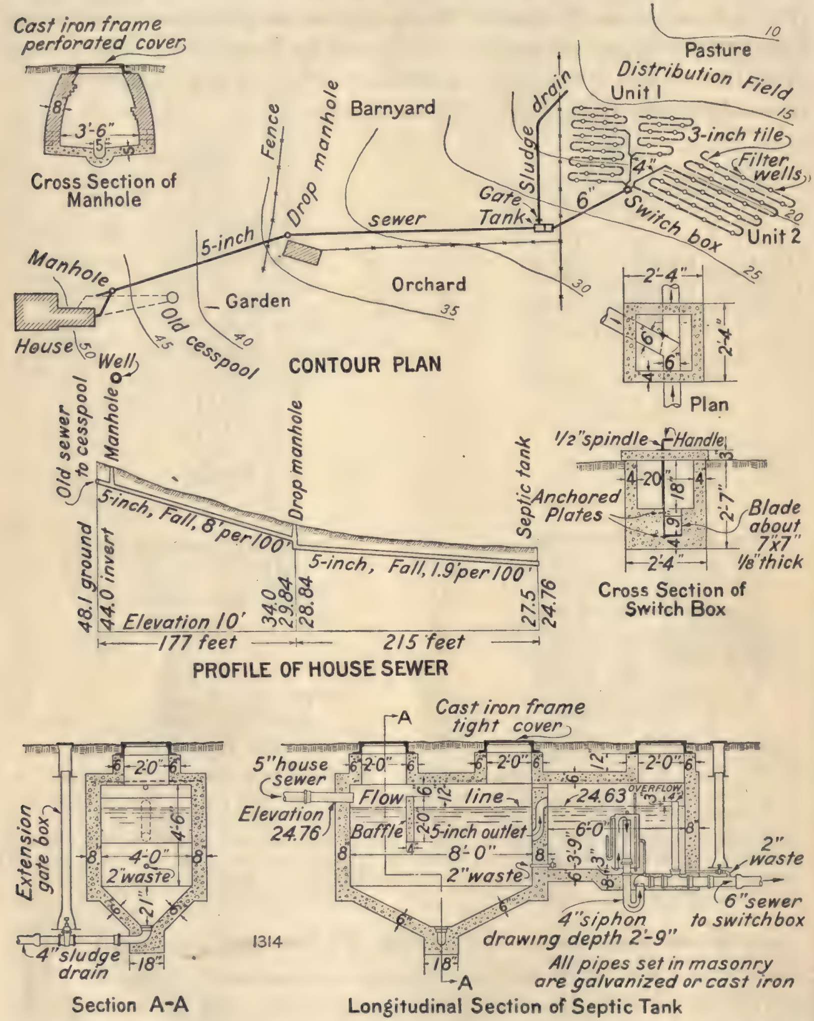


FIG. 34.—A complete installation for a large rural home. General layout on a contour plan and construction drawings. Note abandonment of old cesspool near the well and garden and removal of sewage to a lower and safer location in the pasture, where the treatment is subsurface distribution, aided by numerous filter wells about 4 feet deep filled with coarse gravel. Note that sludge is removed from the bottom of the settling chamber by opening the gate on the sludge drain.

The septic tank is built in one corner of the barnyard, and a 5-inch sewer connects it with the old 4-inch sewers to the cesspool. All sewer pipe joints were poured with a flexible jointing compound. The settling chamber is of hopper shape at the bottom, and a 4-inch sludge drain with gate provides for the gravity removal of sludge. The lower end of the sludge drain is above the surface of the ground and 9 feet below the flow line. The end is protected by a small retaining wall, and the sludge is readily caught in barrels and hauled out on the land for burial. The outlet is low enough to drain the settling chamber completely. If it is desired merely to force out the sludge, the drain may be brought to the surface under a head of 3 to 5 feet, discharging the sludge into a trench or drying bed, to be applied later to the land. A 2-inch waste pipe about mid-depth of the settling chamber permits drawing off the clearer portion of the sewage to the siphon chamber and from thence through another 2-inch waste pipe into the 6-inch sewer leading to the distribution field.

The 4-inch siphon has a drawing depth of 33 inches, and as the siphon chamber is 4 feet wide by 6 feet long the dose is about 500 gallons. The siphon cost $35. The 6-inch sewer to the switch box falls about 6 inches in 50 feet. The distribution field was thoroughly subsoiled, and about 800 feet of 3-inch tile was laid in each unit. At intervals of 25 feet along the distribution trenches 6-inch holes were dug through the clay stratum with a posthole digger. These holes were filled with stone and constitute the filter wells previously mentioned. All tile lines are surrounded with stone and coarse gravel, and the ground has been trimmed to give a uniform cover of 12 inches. All work was done by day labor in a thorough manner. As the men were doing other work at the same time the actual cost is not known, but it is believed the installation cost about $700.

Cost data.—Reliable cost figures are difficult to estimate. Labor, materials, freight, haulage, and other items vary greatly in different localities. The septic tank shown in figure 23 contains about 1,000 bricks and is estimated to cost $60 complete. The septic tank shown in figure 25 for 5 persons is estimated to cost $135; for 10 persons, $170; for 15 persons, $240; for 20 persons, $280. In Maryland, in 1916, the cost of installing a septic tank similar to that shown in figure 25 (for 5 people), including 86 feet of 5-inch house sewer (55 feet of cast-iron pipe passing a well, and 31 feet of vitrified pipe) and 214 feet of second-quality 4-inch sewer pipe in the distributon area, was as follows:

Excavation, labor	$7.50
Materials delivered	46.60
Three-inch siphon, including freight	15.75
Construction, labor	28.00
Supervision	5.00
Total	102.85

The quotations in the following table will be found useful in making estimates of cost:

Cost of pipe and drain tile.

(February, 1921.)

Kind of pipe.	Size, in inches.			
	3	4	5	6
Extra heavy cast-iron soil pipe, on cars Chicago, Ill., or Washington, D. C. . . . per foot. .	$0.34	$0.46	$0.61	$0.72
Vitrified salt-glazed sewer pipe, on cars Chicago, Ill. . . . do. . . .	.15	.15	.22½	.22½
Vitrified salt-glazed sewer pipe, at factory near Washington, D. C. do. . . .	.12	.12	.18	.18
Clay or shale drain tile, at factory in Ohio. . . . do. . . .	.03	.03½	.04½	.05½
Clay or shale drain tile, at factory near Washington, D. C. . . . do. . . .	.04	.05	.06	.07

The cost of cast-iron fittings may be roughly estimated as follows: Bends, one to one and one-half times the price of straight pipe; T-branches, two times the price of straight pipe; reducers, average of the the prices of straight pipe at each end. The cost of clay bends, T-branches, reducers, and increasers may be roughly estimated at four times the price of straight pipe.

Operation.—Attention must be given to every plant to insure success. Unusual or excessive foulness should be investigated. No chemicals should be used in a septic tank; garbage, rags, newspaper, and other solids not readily soluble in water should be kept out of sewers and tanks. The plant should be inspected often, noting particularly if the siphon is operating satisfactorily. If scum forms in the settling chamber it should be removed, and the sludge should be bailed or pumped out yearly. Frequently tanks are not cleaned out for three or four years, resulting in large quantities of solid matter going through to the distribution system and clogging it. Clogging may occur in the tile or in the adjacent soil. In either case the tile should be dug up, cleaned, and relaid. In some cases it has been found advantageous to relay the tile between the former lines. When sewage is applied to fairly porous land at the slow rate here recommended and the plant is well handled the tile lines should operate satisfactorily for many years. Liming heavy soils tends to loosen and keep them sweet.

Field data.—As a basis for outlining or designing a suitable installation the following data should be known:

1. State, town, and whether in or near an incorporated municipality.
2. Usual number of persons to be served.
3. Average daily consumption of water in gallons.
4. Kind and depth of well, depth to water surface.
5. Character of soil, whether sandy, gravelly, loamy, clay, or muck.
6. Condition of soil as to drainage.

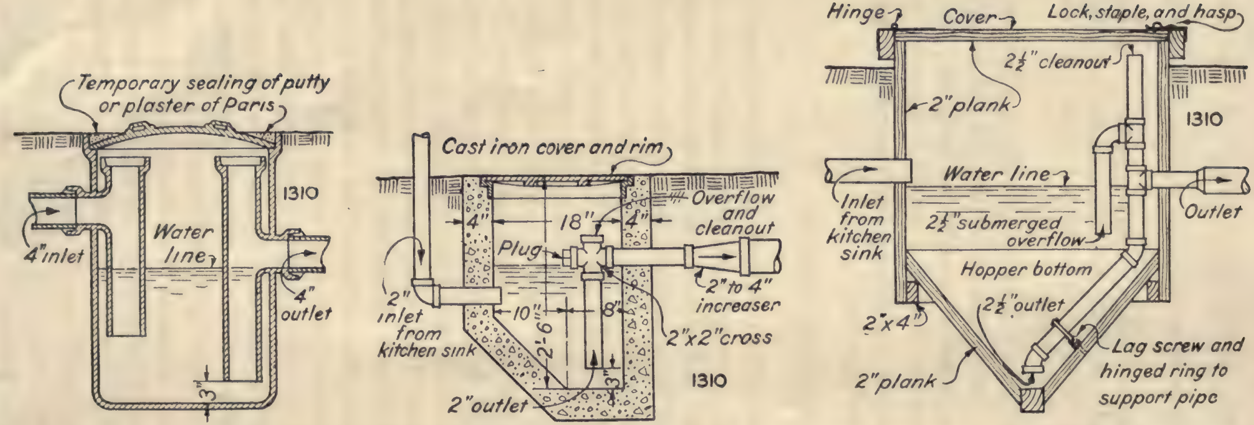
7. Character of subsoil.
8. Character of underlying rock and, if known, its depth below the surface.
9. Depth to ground water at both house and field where sewage is to be distributed.
10. Minimum winter temperature and approximate depth to which frost goes.
11. Number and kind of buildings to be connected with the sewer.
12. Number and kind of plumbing fixtures in each building.
13. Whether plumbing fixtures are to be put in the basement.
14. Depth of basement floor below ground.

A plan to scale or a sketch with dimensions showing property lines, buildings, wells, springs, and drainage outlets should be furnished. The direction of surface drainage should be indicated by arrows. The slope of the land (vertical fall in a stated horizontal distance) should be given or if possible a contour plan (showing lines of constant elevation) should be furnished.

GREASE TRAPS.

Farm sewage may contain from 10 to 30 pounds of grease and fats per person per year. This grease, originating mainly in the kitchen sink, hinders septic action and clogs pipes, filters, and soils. Half the grease may be stopped by a septic tank, but the remainder goes into the distribution system, interfering with its action. A grease trap is a device for separating the grease from other wastes. The need for it may be lessened by carefully depositing waste greases and fats with the garbage; but one should always be installed if the kitchen is carelessly managed or discharges quantities of greasy water as at institutions, hotels, boarding houses, and bakeshops.

A grease trap should have several times the capacity of the greatest quantity of greasy water discharged into it at one time, in order that the entering water shall be well cooled and the grease congealed. The solidified grease rises to the surface of the water in the trap and is retained therein. A dishpan of greasy water (2½ to 3 gallons) is the largest quantity likely to be discharged at one time from an ordinary kitchen sink, hence the grease trap should have not less capacity than 7 or 8 gallons. Figure 35 shows three types of grease traps suitable for farm use. In each the outlet pipe has small clearance at the bottom. This feature, together with the V-shaped hopper bottom, tends to create a scouring velocity and thus prevent the accumulation of coffee grounds and other solid wastes in the bottom of the trap. A grease trap should be close to the sink it is intended to serve, but not within the kitchen, on account of objectionable odors when the trap is opened to remove grease. It is good practice to place the trap in the cellar or basement, where it is safe from frost yet close to the source of grease.



Ready-made grease trap. Vitrified, salt-glazed earthenware.

STOCK SIZES.

Diameter.	Depth.
Inches.	*Inches.*
15	24
18	36
24	36

Home-made grease trap. Concrete or well-plastered brick work; elbow, cross and increaser to be recessed drainage fittings.

Type of grease trap used at U. S. Army camps.

FIG. 35.—Three types of grease trap.

GENERAL PROCEDURE.

Do not waste money by digging and partly constructing, afterwards seeking information. Prepare a plan and work from it. Get in touch with your county agricultural and home demonstration agents. Advice may be obtained also from extension workers, State agricultural colleges, State and local boards of health, the United States Public Health Service, and the United States Department of Agriculture. Do not guess distances and levels. Use a measuring tape and some type of level—engineer's, architect's, drainage, hand, or carpenter's. Study this bulletin, and design, lay out, and construct in accordance therewith. Remember to: (1) Isolate the septic tank—locate it 50 to 100 or more feet from any dwelling and, if practicable, to the leeward of prevailing summer breezes; (2) locate the cesspool or sewage distribution field downhill from the well or spring, and, if possible, 300 feet therefrom; (3) select dry, porous, deeply drained ground for disposal of all sewage; (4) do not apply more sewage to a given area of land than can be thoroughly absorbed and oxidized; (5) lay sewers straight and below the reach of frost, ventilate them thoroughly, and make the joints water-tight and root-proof.

Makeshift methods, materials, or devices should be avoided or used sparingly. Do not place a vent pipe in the top of a cesspool or septic tank if near a dwelling. Siphon chamber and siphon may be omitted in those rare instances where it is feasible to discharge into salt water or into a large stream already badly polluted. Disposal of sewage in a running stream should be a last resort. Such practice endangers water supplies downstream, and unless the volume and velocity of flow are good nuisance may be created in the vicinity. Do not neglect inspection and operation. Clean out settling tanks yearly or oftener. All pipe lines below ground should be marked with iron or stone markers to facilitate examination, repair, or extension of the system.

There is a general but erroneous belief that the cost of sewerage is little in the city but almost prohibitive in the country. All personal and realty properties in one eastern city represent a valuation of $10,382 per home, which pays $355 for sewers outside the cellar wall. An average farm in a Middle West State represents a valuation of $17,259. Is not the farmer justified in the small outlay required to dispose of the farm sewage? Because of the issuance of bonds and the apportionment of sewer assessments for a series of years the city dweller may have his burden distributed over a long period. The farmer does not pay interest on these obligations, and sewer work can be done more cheaply in the country than in the city.

Safe disposal of farm sewage is not a passing fad but a vital necessity. Besides being an asset a good sewerage installation greatly promotes the wholesomeness and healthfulness of the farm. Moreover the benefits are far-reaching, because farm products go into every home, and farm and urban populations mingle freely.

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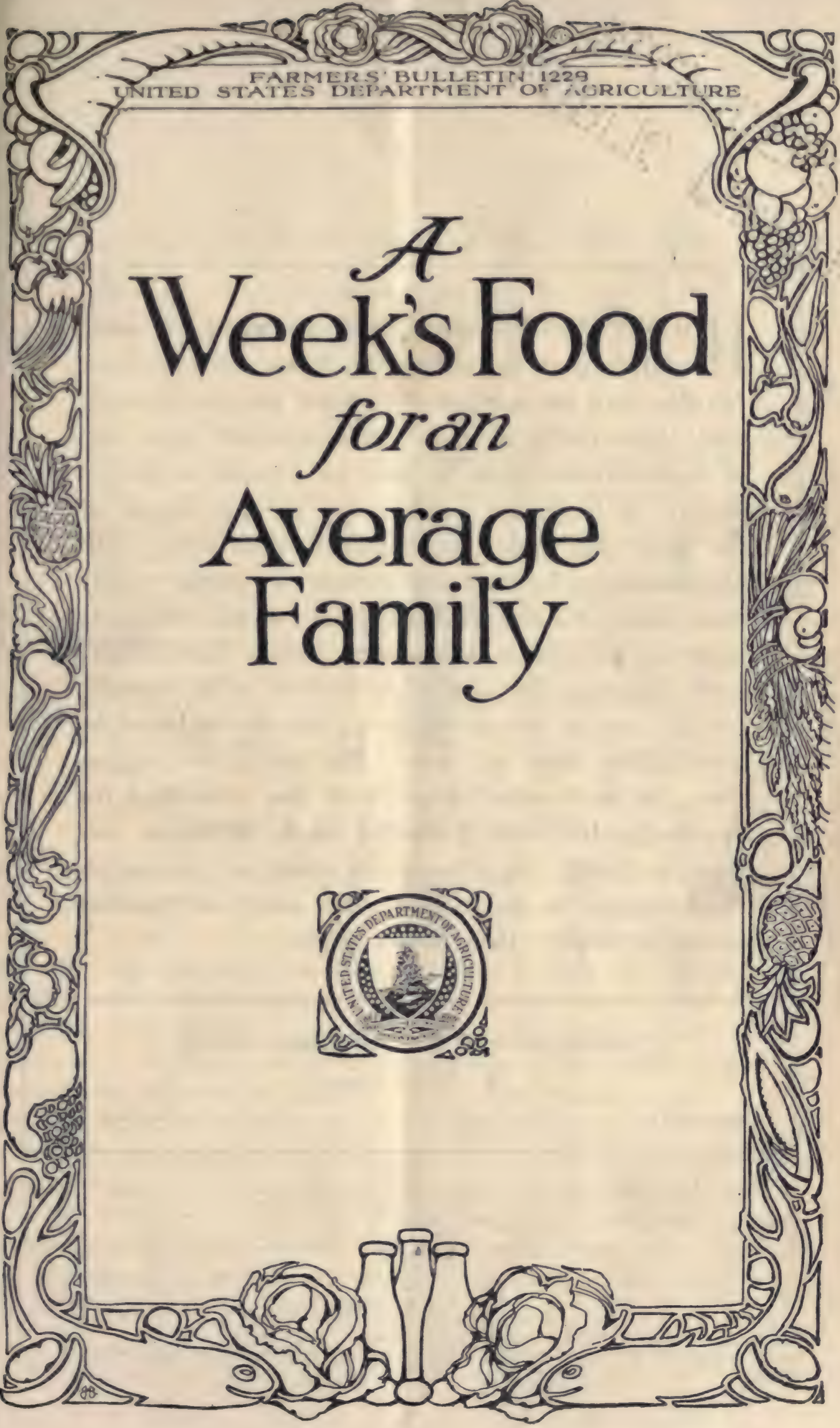
FARMERS' BULLETIN 1228
UNITED STATES DEPARTMENT OF AGRICULTURE

A Week's Food for an Average Family



HOUSEKEEPERS often feel the need of some simple plan by which the foods used in their families can be compared in kind and in quantity with those really needed. This calls for some sort of standard that may be used as a guide in the selection of foods for any family at any season of the year and under any market conditions. This bulletin shows by means of pictures a sample weekly food supply for the average family so planned as to come up to these requirements. Every food shown, with the exception of that part of the milk intended for the use of young children, can be replaced by some other food or foods. The text gives suggestions for such substitutions and also a method for comparing the costs of similar foods. It shows, too, how to change the allowances given in the sample food supply so as to meet the needs of families larger or smaller than the average.

Contribution from the States Relations Service

A. C. TRUE, Director

Washington, D. C. December, 1921

A WEEK'S FOOD FOR AN AVERAGE FAMILY.

CAROLINE L. HUNT,
Specialist, Office of Home Economics.

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KINDS OF FOOD NEEDED.

THE number of different food materials available in most parts of the United States is very great and is constantly increasing as a result of improved methods of agriculture, the invention of new manufacturing processes, the introduction of foreign food plants, and the cultivation of wild varieties. There is no one of all these many foods that can not be introduced into the diet in such a way as to contribute to its wholesomeness or its attractiveness, but the number of different kinds of food needed is very small. Many food materials, the various cereals for example, serve practically the same purpose in the diet. In fact, most of the foods in common use may, as suggested in other publications of this department,[1] be classified into five groups according to their composition and uses, namely, (1) vegetables and fruits, (2) milk, meat, and other foods depended on for complete or efficient protein, (3) cereals, (4) sugar and sugary foods, and (5) fats and fat foods.

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[1] U. S. Dept. Agr., Farmers' Bulletin 808, How to Select Foods: I. What the Body Needs.

A meal, a day's ration, or a weekly food supply made up from representatives of all these five groups is likely to provide all the substances required to make the diet wholesome and attractive, and for this reason the classification should serve as a guide in the selection of foods and the planning of meals. It should be of some help, too, in comparing the cost of different foods, for it separates foods that have little or nothing in common, and brings together under one head food materials that can reasonably be compared in price. For example, to know that a pound of salt codfish costs 10 cents more than a pound of prunes does not make economical meal planning easier. It is helpful, however, to know that one kind of breakfast cereal costs 7 cents, while another that might be substituted for it costs 15 cents, or that a certain amount spent for an inexpensive kind of fruit will bring as good returns in food value as twice that amount spent for some out-of-season variety.

The illustrations for this bulletin are taken from a set of eight charts prepared by the Office of Home Economics to show the principles of food selection. Five of these charts show sample or suggestive weekly food supplies of the five different groups of food mentioned in the preceding paragraph. The information on the other charts, which is chiefly descriptive and explanatory, is also reproduced in this bulletin; but it has been somewhat expanded by the addition of certain details which for lack of space were omitted from the original charts.

GROUP I. VEGETABLES AND FRUITS.

Vegetables and fruits are depended on for flavor, bulk, mineral substances, particularly iron, and for vitamines, of which at least three kinds, called A, B, and C, are now considered necessary. Spinach stands out among the other foods of this group because of its exceptionally large percentage of iron. The green-leaf vegetables as a class, including lettuce, spinach, kale, dandelion greens, the green tops of turnips, or of beets, or of radishes, and many other vegetables commonly used for salads and greens, are especially useful in supplying vitamine A, which is now believed to be necessary for normal growth and for the continued bodily well-being even of adults. Practically all the vegetables and fruits furnish vitamine B, which is, however, so widely distributed among natural food materials that it presents less of a problem to the housekeeper than either of the others. The two chief sources of it are the vegetables and fruits and the so-called whole-grain cereals. Many fruits have been found to supply vitamine C. Lemons, oranges, and tomatoes are considered especially rich in it, and some of the vegetables, notably cabbage and some varieties of turnips, contain comparatively large amounts. White potatoes are also considered an important source of this vitamine in the diet, not because they supply much, pound for pound, but because being mild in flavor and comparatively cheap they are used in larger amounts in most families than any other one vegetable.

It is now believed that the vitamines are to some extent destroyed by drying and also by cooking, particularly in the presence of soda. Probably no two foods are affected to the same extent, and even if the effect on every food were known, the facts would be difficult to keep in mind. In the absence of definite available knowledge on this subject it is wise for the housekeeper to use regularly some uncooked fruits or tomatoes, fresh or canned, and some green-leaf vegetables. The last mentioned should be used either raw or cooked only enough to make them taste good and without unnecessary loss of their juices. Canned and dried vegetables and fruits may all be used for the sake of economy or convenience or to give bulk to the diet, but never to the exclusion of green-leaf vegetables and fresh fruits. There is no way at present of measuring the exact amount of fruit juices needed for health. It seems probable, however, that it is not large, and the housekeeper who can not afford to serve whole oranges, grapefruit, or fresh tomatoes is probably on the safe side, if she makes a practice of introducing small amounts of tomato, orange, or lemon juices into her bill of fare. An orange cut up with other fruits or a little lemon juice added to sliced bananas, stewed prunes, or other fresh or dried fruits is helpful. There are many desserts and beverages, too, in which small amounts of orange or lemon juice can be used, and many gravies, sauces, and soups that are improved by a little tomato juice. Regularity of supply is probably more important than the use of large amounts.

GROUP II. FOODS DEPENDED ON FOR EFFICIENT PROTEIN.[2]

Under the head of foods that furnish efficient protein come milk; eggs; cheeses of various kind; flesh foods, including lean and medium fat meats; fish, poultry, game, and sea foods; peanuts and soy beans. These foods, though differing much in other respects, are alike in furnishing a kind of protein that is capable of replacing the protein found in the tissues of the body. Such foods as bacon, salt pork, fat pork sausage, and cream furnish the same kind of protein as the foods of this group, but far less of it, pound for pound. As a rule, if a food contains two and a half times as much fat as protein, it is listed among the foods of Group V, which are depended on to give richness to the diet rather than to furnish protein.

Milk is especially rich in lime, and meat and eggs in iron. Milk, especially in the summer, and eggs supply vitamine A. In the diet of the adult all the foods of this group may be considered interchangeable. In the diet of children, however, nothing can take the place of milk.

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[2] U. S. Dept. Agr., Farmers' Bulletin 824, How to Select Foods: III. Foods Rich in Protein.

GROUP III. CEREAL GRAINS AND THEIR PRODUCTS.[8]

The cereal-grain foods are flour, meal, breakfast foods, bread, rolls, crackers, and all other foods that are made wholly or chiefly from the cereal grains, namely, wheat, corn, rye, rice, barley, and oats. These cereal foods are depended on to supply protein, starch, and, particularly if they are made from the whole grain, mineral substances, and vitamines. Vitamine B is found so near the germ that it is likely to be lost if the germ is removed. The mineral substances are found chiefly in the germ and in the outer coatings of the grain. It is generally agreed that cereal foods keep better if the germ has been removed, and many people prefer white to whole-wheat flour because it makes lighter bread. However, if white bread only is served, care should be taken either to introduce whole-grain cereals into the diet as breakfast foods or in some other way, or to provide an unusually large proportion of vegetables and fruits. (See p. 4.)

GROUP IV. SUGAR AND SUGAR FOODS.

The sugar foods are sugars of different kinds, including granulated, pulverized, lump, brown, and maple; molasses; honey; sirups; candy; sweet chocolate; rich preserves; jellies; jams and marmalades. These foods can be depended on for fuel and flavor, but not for protein, vitamines, and mineral substances. They are therefore not as essential as the other groups. It should be said, however, that sugar at ordinary prices is an economical body fuel and a very economical flavoring material as compared with most extracts and even with spices. If sweets are used in proper proportions to other food materials and are not served in such a way as to destroy the appetite for other foods, they have an important place in the diet.

GROUP V. FATS AND FAT FOODS.

Fats and fat foods include butter, oil, lard, suet, and other table and cooking fats; cream; bacon; salt pork; pork sausage; chocolate; and rich or oily nuts. Most of these foods are prepared by separating fat from natural food materials such as milk, meat, olives, and cotton seed. It is better to use them in this separated form because in this way the richness and flavor that they give to the diet are more easily distributed through the other foods. Some of the fat foods, especially butter and cream, furnish vitamine A and for this reason have great advantage over the other foods of the group, particularly when milk and green-leaf vegetables can not be obtained in sufficient amounts.

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[8] U. S. Dept. Agr., Farmers' Bulletin 817, How to Select Foods: II. Cereal Foods.

GOOD PROPORTIONS FOR THE DIET.

All of the foods mentioned in the preceding paragraphs, and in fact all foods, furnish body fuel or material that can be burned in the body to give it energy and incidentally to keep up its temperature. The fuel supplied by Group I, the vegetables and fruits, is chiefly sugar and starch; that supplied by Group II, namely, milk, meat, eggs, and cheese, chiefly complete or efficient protein and fat; that supplied by Group III, the cereals, chiefly protein and starch, the latter being usually six or seven times as much by weight as the former; that supplied by Group IV, the sweets, almost exclusively sugar; and that supplied by Group V, almost exclusively fat. As a rule, the diet will be sufficiently bulky and flavorful and will furnish the right proportions of starch, fat, and sugar for the taste of most people if the vegetables and fruits furnish about 20 per cent of the fuel; the milk, meat, eggs, and similar foods, 20 per cent; the cereal foods, 30 per cent; sweets, 10 per cent; and fats and fat foods, 20 per cent. A diet made up on these proportions will also furnish satisfactory kinds and amounts of protein, mineral substances, and vitamines. These proportions have therefore been adopted in making up the sample weekly food supplies of different kinds of foods shown on pages 8 to 16. Many other combinations would answer the purpose equally well.

ENERGY VALUES AS COMPARED WITH WEIGHTS.

It is far more difficult to state briefly and accurately the amounts of foods needed than to enumerate the kinds that should be used. The amounts of foods needed for a given person or family are usually stated in one of two ways: (1) In terms of such familiar units as pounds, bushels, and dozens; or (2) in terms of units by which energy or the power to do work is measured, that is, in calories and hundred-calorie portions. Rules for estimating the amount of food needed in terms of calories and hundred-calorie portions are easy to make but troublesome to follow, for foods are not at present bought or sold by calories or hundred-calorie portions, nor are these units used in recipes. On the other hand, exact rules expressed in terms of pounds, dozens, and other familiar units are very difficult to make. The chief reason for this is that food materials differ greatly, not only in the kinds of nutrients they contain, but also in the amount of water and of inedible material such as bone and shell. Even those foods that serve practically the same purpose in the diet are not interchangeable, pound for pound. For example, a pound of sugar provides 16 ounces of sugar; a pound of honey, about 12 ounces of sugar; and other sweet foods in common use differ even more. It goes without saying that if a family uses candy, sirup, molasses, honey, and rich preserves purchased as such, it can not safely use so much sugar as it would otherwise; but it is quite impossible to state the total number of pounds of sweets that can be wisely used without knowing which ones are to be selected and in what proportions they are to be used.

For such reasons as those given above, the amounts of the various kinds of foods that are necessary or desirable are stated in two ways in this bulletin, by weight and by hundred-calorie portions. This is done in the belief that estimates in pounds, dozens, and quarts may be more useful to some housekeepers and that estimates in hundred-calorie portions may, because of their greater definiteness, be more useful to others.

In most cases the suggested allowances of foods from a given group are given first in the terms of some familiar member of the group. After that, suggestions are made for the substitution of other foods which serve the same purpose. For example, under Group III it is said that 15 pounds of dry cereal foods, which of course include the flour used in making bread, is a good weekly allowance for the average family. Many people, however, buy bread instead of having it prepared at home, and so the statement is made that a pound of bread usually contains about three-fourths of a pound of flour, and therefore counts as three-fourths of a pound of dry cereal in making up the total allowance.

THE "AVERAGE" FAMILY.

The illustrations show the amount of food needed weekly by the "average" family. This family is supposed to consist of a father and a mother both doing moderately active muscular work and three young children whose ages total as least 20 years but not more than 24 years, or of four "average" adults. The average adult is represented by a man who does little or no muscular work, or by a woman who does hard muscular work like washing or cleaning for 8 hours a day. Boys of 12 years or more and men who do moderately hard muscular work need more than the average; many women need less. The foods pictured, figures 1 to 5, together supply about 80,000 calories, or 800 hundred-calorie portions. Most farm families do more active muscular work and so need more energy than is here allowed for the average family. The needs of other families than the average family may be estimated by means of the table on page 20.

A WEEK'S SUPPLY OF VEGETABLES AND FRUITS FOR AN AVERAGE FAMILY.

A sample weekly supply of vegetables and fruits for the average family is shown in figure 1. This supply represents about 70 pounds fresh weight or about 160 hundred-calorie portions of vegetables and fruits. It is believed that this amount if regularly used will insure the required bulk and mineral substances, even though some of the vegetables and fruits are canned and some dried; and that it will also furnish the required vitamines, provided green-leaf vegetables and fresh fruits are regularly included in small amounts. The separate items in the sample supply are as follows:

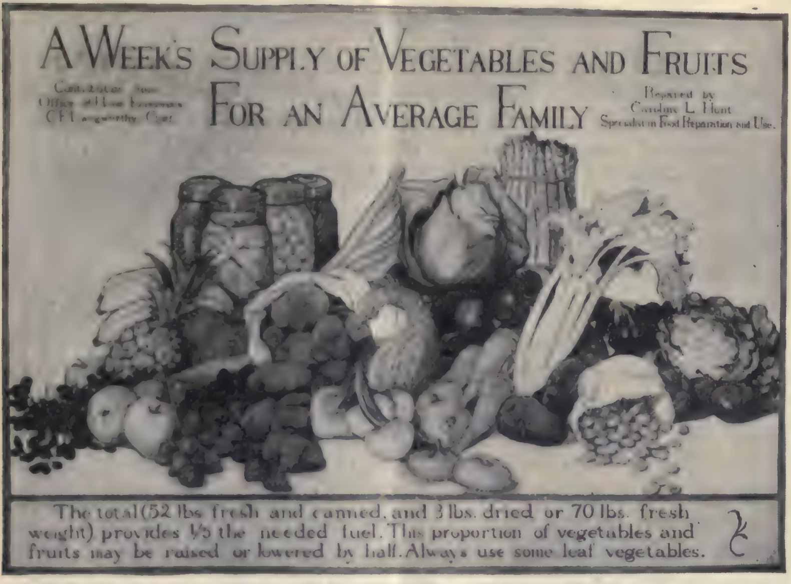

A WEEK'S SUPPLY OF VEGETABLES AND FRUITS
FOR AN AVERAGE FAMILY
Contribution from Office of Home Economics C. F. Langworthy, Chief
Prepared by Caroline L. Hunt Specialist in Food Preparation and Use.
The total (52 lbs. fresh and canned, and 3 lbs. dried or 70 lbs. fresh weight) provides 1/5 the needed fuel. This proportion of vegetables and fruits may be raised or lowered by half. Always use some leaf vegetables.

FIG. 1.—U. S. Department of Agriculture chart showing vegetables and fruits, fresh, canned, and dried, which together supply about 160 hundred-calorie portions. Any other combination of ordinary vegetables and fruits equivalent to 70 pounds of fresh material would supply about the same amount of body fuel.

	Pounds.
Fresh vegetables and fruits:	
Potatoes, white, ½ peck	7
Potatoes, sweet, ½ peck	7
Asparagus	2
Beets, with greens	2
Carrots	2
Cabbage	2
Squash	2
Turnips	2
Celery	1
Lettuce	1
Onions	2
Tomatoes, 4 medium-sized	1
Rhubarb	1
Bananas, 1 dozen medium-sized	3
Oranges, ½ dozen medium-sized	3
Fresh vegetables and fruits—Con.	
Apples, 8 medium-sized	3
Pineapple (1)	2
Strawberries, 1 quart	1
Total	44
Canned vegetables and fruits:	
Peas, 1 quart	2
String beans, 1 quart	2
Cherries, 1 quart	2
Peaches, 1 quart	2
Total	8
Dried vegetables and fruits:	
Lima beans	2
Raisins	1
Total	3

HOW TO ESTIMATE THE NUMBER OF POUNDS FRESH WEIGHT.

When all the vegetables and fruits used are fresh it is easy to estimate the weight, but when some are dried and some are canned it may be difficult. Vegetables and fruits lose on the average about five-sixths of their weight when they are dried, the loss being sometimes due to the removal of inedible portions, but chiefly to the passing off of water. A given number of pounds, dried, therefore, is likely to furnish as much fuel and mineral substances as six times that number of pounds fresh. A given number of pounds of canned vegetables and fruits, on the other hand, seldom corresponds in fuel and mineral substances to more than the same number of pounds fresh or as purchased, i. e., before skins, seeds, pods, outer leaves, and other inedible portions have been removed. In making up the sample supply of vegetables and fruits in the picture, it was estimated that the 8 pounds of canned peas, string beans, cherries, and peaches correspond roughly with 8 pounds of these same foods fresh, and that the 3 pounds of dried lima beans and raisins correspond roughly with 18 pounds of fresh lima beans and grapes. The 44 pounds of fresh vegetables and fruits, the 8 pounds canned, and the 3 pounds dried together represent, roughly, 70 pounds fresh weight.

This method of estimating the original or fresh weight of the vegetables and fruits used in the course of a week is recommended to the housekeeper who wishes to keep her food supply up to the standard. Dried and canned vegetables and fruits can never wholly take the place of fresh vegetables and fruits; but if only a small part of the 70 pounds can be obtained in fresh form, it is better to make up the remainder in the form of dried and canned products than to reduce the total.

HOW TO ESTIMATE THE ENERGY VALUE OF THE VEGETABLES AND FRUITS.

The fuel or energy values per pound of the different vegetables and fruits differ considerably, but from dietary studies made in the Office of Home Economics it has been found that the fresh and canned vegetables and fruits in the variety in which they are used in most families seldom represent less than 225 calories, or 2¼ hundred-calorie portions per pound, and that the dry vegetables and fruits seldom represent less than 1,350 calories, or 13½ hundred-calorie portions per pound. According to these figures the fresh and canned vegetables and fruits in the sample weekly supply should furnish at least 117 hundred-calorie portions and the dried at least 40½ hundred-calorie portions, making a total of 157½ hundred-calorie portions for the group, or about 20 per cent of the total 800 hundred-calorie portions needed. In this way the amount of fuel furnished by the vegetables and fruits in any food supply and the proportion of this fuel to the total fuel needed can be quickly estimated.

A WEEK'S FOOD SUPPLY OF EFFICIENT-PROTEIN FOODS FOR AN AVERAGE FAMILY.

Figure 2 shows a sample weekly food supply of milk and other foods depended on for efficient protein such as would be needed by the average family. The supply includes 14 quarts of milk and 10½ pounds of flesh foods, cheese, eggs, and peanuts, or about 160 hundred-calorie portions, of which about half are supplied by the milk. The separate items are as follows:

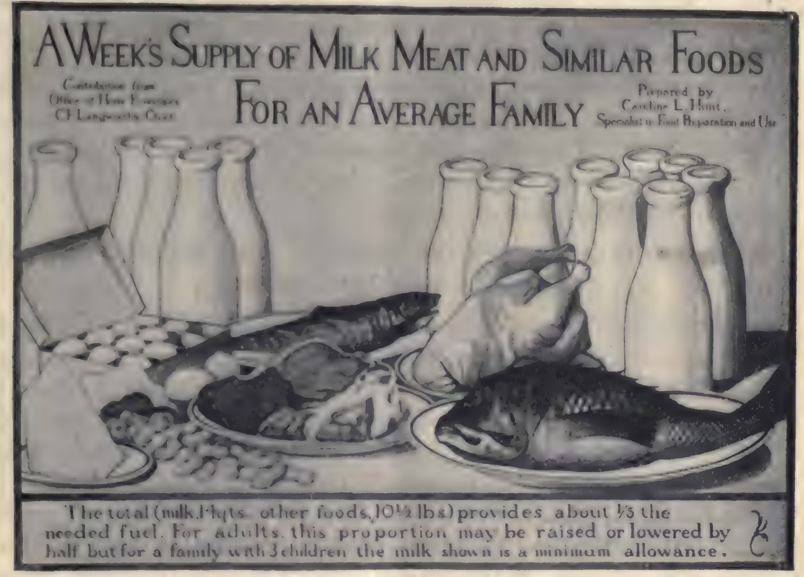

A Week's Supply of Milk Meat and Similar Foods
For an Average Family
Contribution from Office of Home Economics C. F. Langworthy, Chief
Prepared by Caroline L. Hunt, Specialist in Food Preparation and Use
The total (milk 14 qts. other foods, 10½ lbs.) provides about ⅓ the needed fuel. For adults this proportion may be raised or lowered by half but for a family with 3 children the milk shown is a minimum allowance.

FIG. 2.—U. S. Department of Agriculture chart showing efficient-protein foods which together supply 160 hundred-calorie portions. Any other combination, consisting of 14 quarts of milk and 10½ pounds of flesh foods, cheese, and eggs, would furnish about the same amount of body fuel.

	Quarts.
Milk	14
	Pounds.
Beef, sirloin	2
Fowl	3
Fish, fresh, lean	2
Fish, dried	¾

	Pounds.
Cheese	¾
Eggs, 1 dozen	1½
Peanuts, 1 quart	½
Total	10½

Children need more milk than adults, and the number of quarts that should be used depends on the family. The 14 quarts shown in the picture is believed to be as little as is safe for a family of 2 adults and 3 children. For this family 3 quarts a day, or 21 quarts a week, would be a better allowance, and would furnish daily 3 glasses for each child and a small amount for general use. Since the added quart of milk would be chiefly for children, it would hardly be practicable to reduce the other foods much. A family of four adults would probably use less milk than the amount shown in the picture and more meat, cheese, and eggs. For such a family 1 quart of milk and 2 pounds of the other foods would be a more usual daily allowance.

The amount of meat and other flesh foods shown in the figure is doubtless less than that used in most families whose incomes allow them to select the foods they desire. The meat, eggs, cheese, and similar foods, together with the vegetables, fruits, milk, cereals, and other foods shown in the other illustrations correspond to an allowance of at least 88 grams, or somewhat more than 3 ounces, of protein per man per day, which is more than many authorities think necessary for health. The only good argument, therefore, for increasing such foods would be that the members of the family do not feel satisfied with the amount suggested.

THE RELATIONSHIP BETWEEN WEIGHT AND ENERGY IN THE EFFICIENT-PROTEIN FOODS.

The number of hundred-calorie portions that can be counted upon from the foods of the efficient-protein group is not easy to state except in the case of milk. A quart of whole milk supplies about 6 hundred-calorie portions and a quart of skim milk or buttermilk about 3 hundred-calorie portions. The 14 quarts of whole milk shown in the illustration represent, therefore, about 84 hundred-calorie portions. It has been found (see p. 22) that the meat, eggs, and similar foods used in most families average at least 8 hundred-calorie portions per pound. The foods in the illustration, some of which are fat and some lean, were chosen to correspond with this average and to supply about 85 hundred-calorie portions. It is true that the flesh foods, eggs, cheese, etc., used in the course of a week in a given family may represent less fuel than this per pound. They certainly will if they consist chiefly of fresh fish, chicken, or eggs, all of which are below the average in energy value. On the other hand, they will represent more than 8 hundred-calorie portions per pound if they consist chiefly of pork, lamb, cheese, or peanut butter, all of which are above the average. During the course of a month or a year, however, it is safe to count on an average of at least 8 hundred-calorie portions per pound from foods of this kind.

A WEEK'S SUPPLY OF CEREAL FOODS FOR AN AVERAGE FAMILY.

A sample weekly supply of cereal foods for the average family is shown in figure 3. This supply corresponds to about 15 pounds of dry cereals, such as flour, meal, and ready-to-eat breakfast foods, and supplies about 240 hundred-calorie portions. It is believed that if this amount of cereal foods is used regularly in addition to the vegetables, fruits, milk, meat, and other foods shown in the figures on pages 9 and 11, the diet will be sure to supply enough protein and the proportion of starch to sugar and fat will make it palatable. Many well-to-do families, however, prefer less cereals and more meat. The separate items are as follows:

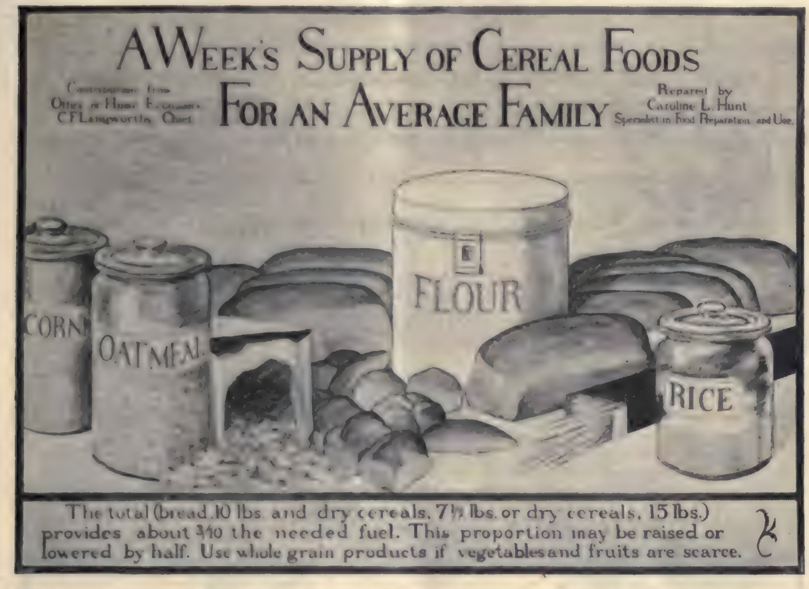

A WEEK'S SUPPLY OF CEREAL FOODS
FOR AN AVERAGE FAMILY
Contribution from Office of Home Economics C F Langworthy Chief
Prepared by Caroline L. Hunt Specialist in Food Preparation and Use.
CORN
OATMEAL
FLOUR
RICE
The total (bread 10 lbs. and dry cereals, 7½ lbs. or dry cereals, 15 lbs.) provides about 3/10 the needed fuel. This proportion may be raised or lowered by half. Use whole grain products if vegetables and fruits are scarce.

FIG. 3.—U. S. Department of Agriculture chart showing bread and other cereal foods which together supply about 240 hundred-calorie portions. Any other combination of cereal foods equivalent to 15 pounds of dry cereal would furnish about the same amount of body fuel.

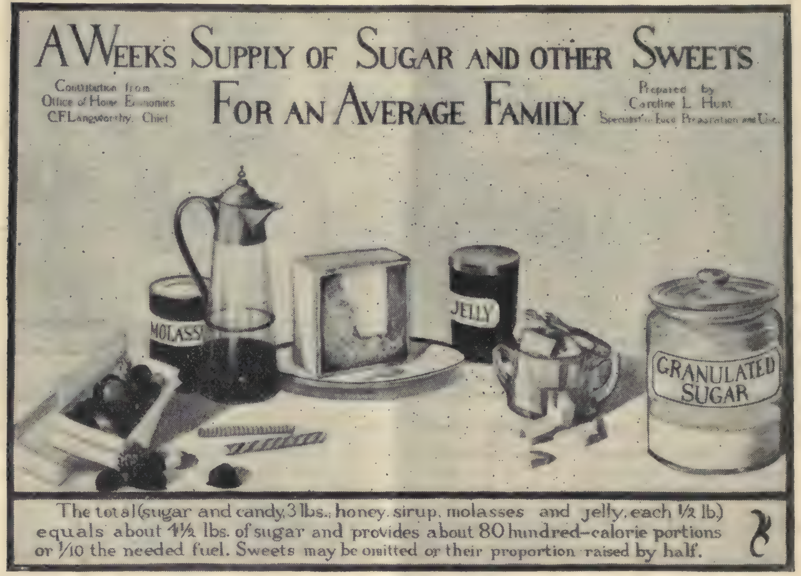
	Pounds.		Pounds.
Flour, 20 cups	5	Ready-to-eat breakfast cereal, 5 to 6 cups	½
Rolled oats, 2½ cups to 3 cups	½	Total	7½
Corn meal, 1½ cups	½	Bread and rolls	10
Rice, 1 cup	½		
Macaroni	½		

HOW TO ESTIMATE THE TOTAL AMOUNT OF CEREALS USED.

Some families make their own bread, some buy bread, and some buy part and make part. Every pound of bread contains approximately three-fourths of a pound of flour. The housekeeper can, therefore, make a rough estimate of the amount of cereal food she uses by adding three-fourths of the weight of bread she buys to the weight of the flour, oatmeal, and other dry cereal food she used in cooking. Take the foods in the picture for illustration. There are 10 pounds of bread and rolls representing three-fourths as much flour, or about 7½ pounds. This added to the 7½ pounds of dry cereals makes a total of 15 pounds.

HOW TO ESTIMATE THE NUMBER OF HUNDRED-CALORIE PORTIONS IN CEREAL FOOD.

It is a comparatively easy matter to estimate the number of hundred-calorie portions that are to be obtained from cereal foods. The dry cereals, including the various kinds of flours, meals, and breakfast foods average about 16 hundred-calorie portions per pound, and no one kind differs much one way or the other from the average. Bread and rolls average about 12 hundred-calorie portions per pound.



The total (sugar and candy, 3 lbs.; honey, sirup, molasses and jelly, each ½ lb.) equals about 4½ lbs. of sugar and provides about 80 hundred-calorie portions or 1/10 the needed fuel. Sweets may be omitted or their proportion raised by half.

FIG. 4.—U. S. Department of Agriculture chart showing sugar and other sweet foods which together supply about 80 hundred-calorie portions. Any other combination of such foods which furnishes about 4½ pounds of sugar would furnish about the same amount of body fuel.

Take the cereal foods shown in the picture as an illustration. The dry cereals may be expected to furnish 7½×16 hundred-calorie portions and the bread 10×12 hundred-calorie portions, making a total of 240 hundred-calorie portions. In this way the fuel value of any combination of cereal foods can be quickly estimated.

A WEEK'S SUPPLY OF SWEETS FOR AN AVERAGE FAMILY.

Figure 4 shows a sample weekly supply of sweets for an average family. These sweets represent about 4½ pounds of sugar or about 80 hundred-calorie portions. It is believed that this amount of sweets if used regularly will contribute to the attractiveness of the diet without interfering with the use of the required amount of protein, mineral substances, and vitamines. The separate items are as follows:

	Pounds.		Pounds.
Sugar, granulated, 4 cups	2	Sirup, about ⅔ cup	½
Sugar, loaf	¼	Molasses, about ⅔ cup	½
Candy	¾	Jelly	½
Honey, about ⅔ cup	½		

HOW TO ESTIMATE THE AMOUNT OF SUGAR IN SWEETS.

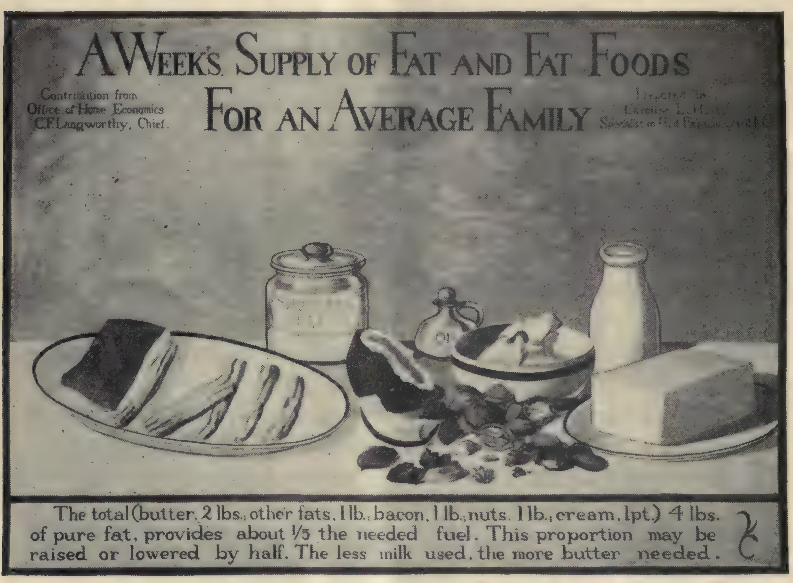
Granulated, lump, pulverized, and brown sugars, though differing in texture or flavor, are practically all alike in composition; they contain little or nothing but sugar. A pound of candy may be considered the equivalent in fuel value of a pound of sugar. Water, which has no fuel value, is used in making candy, to be sure, but so too are chocolate and nut meats, which have higher fuel values than sugar. The average fuel value per pound of candies of various kinds is, therefore, about the same as that of sugar. The amount of sugar in thick sirups, such as honey and molasses, is about three-fourths of a pound to the pound, and in jellies, jams, and rich preserves, about one-half of a pound to the pound. This makes it possible to estimate quickly the total amount of sugar used, whether in the form of sugar itself or in the form of candy, sirups, or preserves. Take the sweets shown in the picture as an illustration. There are 2¼ pounds of sugar itself and three-fourths of a pound of candy, together corresponding to a total of about 3 pounds of sugar. The honey, sirup, and molasses together weigh 1½ pounds, of which about three-fourths, or 18 ounces, is sugar. The jelly weighs one-half pound, and of this about half, or 4 ounces, is sugar. This makes a total of about 4½ pounds of sugar.

HOW TO ESTIMATE THE NUMBER OF HUNDRED-CALORIE PORTIONS IN THE SWEETS.

Sugar itself provides 18 hundred-calorie portions per pound and average candy about the same number. Thick sirups provide about 13½ hundred-calorie portions, and jelly, jams, marmalades, and rich preserves about 9 hundred-calorie portions per pound. With these figures in mind, it is easy to estimate the number of hundred-calorie portions to be obtained from the sweets even when these foods are used in great variety. Take the sweets in the illustration on page 14 as an example. The 3 pounds of sugar and candy may be expected to furnish about 54 hundred-calorie portions; the 1½ pounds of thick sirups (honey, sirup, and molasses) about 20¼ hundred-calorie portions, and the one-half pound of jelly about 4½ hundred-calorie portions. This makes a total of nearly 80 hundred-calorie portions, or about one-tenth of the fuel needed weekly by the average family.

A WEEK'S SUPPLY OF FATS AND FAT FOODS FOR AN AVERAGE FAMILY.

Figure 5 shows a sample weekly food supply of fats and fat foods for the average family. These foods correspond with about 4 pounds of pure fat and represent about 160 hundred-calorie portions. It is believed that this amount of fat, in addition to that supplied by the milk, meat, and similar foods suggested, will make the diet sufficiently rich to taste good. It is believed, also, that the amount of butter, cream, and suet shown will, if used in connection with the milk and green vegetables elsewhere recommended, be enough to keep up the supply of vitamine A. The separate items are as follows:



The total (butter, 2 lbs.; other fats, 1 lb.; bacon, 1 lb.; nuts, 1 lb.; cream, 1 pt.) 4 lbs. of pure fat, provides about 1/5 the needed fuel. This proportion may be raised or lowered by half. The less milk used, the more butter needed.

FIG. 5.—U. S. Department of Agriculture chart showing fat and fat foods which together supply about 160 hundred-calorie portions. Any other combination of such foods equivalent to about 4 pounds of fat would furnish about the same amount of body fuel.

	Pound.
Oil, ½ cup	¼
Shortening fat, 1 cup	½
Suet	¼
Total	1

	Pounds.
Butter	2
Bacon	1
Total	3

	Pounds.
Cream, 1 pint	1
Nuts in shell	1
Total	2

HOW TO ESTIMATE THE AMOUNT OF FAT IN THE FATS AND FAT FOODS.

Oil, suet, lard, and drippings may be considered to be all fat; butter, bacon, salt pork, chocolate, and fat nut meats may be considered to be at least three-fourths fat; and cream and nuts in the shell may be considered to be one-fourth fat. With these figures in mind it is possible to estimate the amount of fat in the fat foods, whether these foods are chiefly butter or chiefly cream, oils, nuts, or other foods commonly used to enrich the diet. Take the foods in the picture for example. The pound of oil, shortening fat, and suet may be considered all fat. The fat in butter and bacon may be considered to be about 2¼ pounds, or three-fourths of their total weight, while the fat in the cream and nuts in the shell may be considered to be 8 ounces, or one-fourth of their total weight. This makes a total of nearly 4 pounds of fat in all.

HOW TO ESTIMATE THE NUMBER OF HUNDRED-CALORIE PORTIONS IN THE FAT AND FAT FOODS.

Pure fat has a fuel value of about 4,000 calories per pound. Butter furnishes about 34 hundred-calorie portions per pound. Bacon, salt pork, chocolate, and fat nut meats average about 28 hundred-calorie portions, and cream and nuts in the shell about 10 hundred-calorie portions per pound. With these figures in mind it is possible to estimate quickly the number of hundred-calorie portions of fat and fat foods shown in the sample weekly supply as not far from 160 hundred-calorie portions, and the same method can be used in estimating the fat in any other list of fats or fat foods.

MEAL PLANNING.

Up to this point, emphasis has been laid on the kinds and relative amounts of foods in the weekly supply, and no mention has been made of the make-up of the separate meals. This was done in the belief that a balanced food supply insures a balanced diet. The common way of using such foods as those shown in the pictures is by serving one or more foods from each of the five groups at each meal. Many people eat for breakfast: Fruit (Group I); either a cereal with milk, or an egg, or warmed-over meat or fish on toast or with bread (Groups II and III); butter or bacon (Group V); and sugar, marmalade, or both (Group IV). The usual bill of fare for lunch or supper includes meat, sliced cold or warmed over, or cheese, or eggs in some form, or a milk soup or chowder (Group II); bread or crackers (Group III); butter or oil (Group V); a green salad or sliced fruit (Group I), and sugar or a sweet of some other kind

(Group IV). Dinner usually consists of meat or one of the so-called meat substitutes (Group II); potatoes and one other vegetable (Group I); bread and butter (Groups III and V); and a sweet of some kind for dessert (Group IV); or bread without butter (Group III) and a rich dessert (Groups IV and V).

Some housekeepers like to do a certain amount of "balancing" as they go along and to serve at least one food from each group at every meal, but this is not necessary. There is no objection in the case of an adult to a breakfast of toast, butter, and coffee, tea, or cocoa (chiefly Groups III and V), if enough vegetables, fruits, and efficient-protein foods are supplied at later meals. Nor is there any reason to think that serious injury would be done by the omission of any one group of food for a whole day, or even longer. For this reason, emphasis has been placed chiefly on the importance of keeping account of the foods served in the course of a week rather than of those in every meal.

Another point to be remembered is that meals are not necessarily well balanced, even if they contain representatives of all the food groups, for much depends on the proportions in which these foods are used. A dinner which includes meat, and also a dessert made of milk and eggs, such as custard or ice cream is likely to supply far more of the efficient protein foods than needed, an important matter since these are among the most expensive food materials. Nor is it possible to judge from the dishes served whether a meal is balanced or not. For example, a meal that includes no meat course, but has in its place only bread and butter with vegetables or fruits may be well-balanced if the dessert is such a dish as old-fashioned rice pudding which has milk for its chief ingredient. If the weekly food supply is satisfactory the exact make-up of the separate meals is not important, though the habit of providing all the required kinds of foods regularly is helpful and likely to save time and thought.

SUGGESTED BILLS OF FARE.

Bills of fare for a week that could be made from the food supply shown in the pictures are given below. It should be remembered that this food supply was planned for an "average" family (see p. 8), and that it should perhaps be modified by increasing or decreasing the amount of milk according to the number of children and adults in the family. When more milk is provided for the young children this would partially take the place of the meat, fish, cheese, or egg dishes.

SUNDAY.

BREAKFAST.	DINNER.	LUNCH OR SUPPER.
Oranges; breakfast cereal with milk; bread or toast with butter.	Chicken[4] stuffed and roasted or fricasseed and served on toast or with rice; sweet potatoes; asparagus; jelly; bread; pineapple ice cream.	Peanut sandwiches with lettuce salad; or bread, milk, and butter for children; candy.

MONDAY.

BREAKFAST.	DINNER.	LUNCH OR SUPPER.
Sliced pineapple and bananas; breakfast cereal with milk; bread or toast with butter.	Macaroni and cheese[4] with warmed-over chicken; boiled cabbage; bread; apple pudding, baked or steamed.	Lima bean chowder; crackers or bread and butter; celery; boiled rice with honey.

TUESDAY.

BREAKFAST.	DINNER.	LUNCH OR SUPPER.
Canned peaches; breakfast cereal with milk; bread or toast with butter.	Beef stew[4] with turnips, carrots, onions, and dumplings; bread; orange custard with nut cookies or sliced oranges with nut cake.	Bacon; boiled potatoes and milk gravy made with bacon fat; cole-slaw; bread and butter; candy.

WEDNESDAY.

BREAKFAST.	DINNER.	LUNCH OR SUPPER.
Canned cherries; breakfast cereal with milk; bread or toast with butter.	Bacon and fried eggs;[4] potatoes; squash; bread; peach pie.	Creamed smoked fish with baked potatoes; bread and butter; sliced oranges with coconut.

THURSDAY.

BREAKFAST.	DINNER.	LUNCH OR SUPPER.
Bananas; breakfast cereal with milk; bread or toast with butter.	Meat cakes[4] with tomato sauce; lima beans; bread; baked bananas.	Cheese sandwiches or scalloped cheese and rice;[4] lettuce; bread and butter; wheat cakes with sirup.

FRIDAY.

BREAKFAST.	DINNER.	LUNCH OR SUPPER.
Stewed raisins and rhubarb; breakfast cereal with milk; bread or toast with butter.	Fish, stuffed or baked;[4] sweet potatoes; beets with greens; bread; suet pudding with raisins.	Cream of pea soup; scalloped sweet potatoes; bread or biscuits and butter; canned cherries.

SATURDAY.

BREAKFAST.	DINNER.	LUNCH OR SUPPER.
Baked apples; breakfast cereal with milk; bread or toast with butter.	Scrambled eggs with smoked fish;[4] string beans; celery; bread and butter; strawberry shortcake.	Creamed fish on toast or boiled rice; bread and butter; raisin tarts.

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[4] Bread and milk instead of this for young children.

COMPARING ONE'S OWN FAMILY WITH THE "AVERAGE" FAMILY.

On page 8 the statement is made that the average family needs about 800 hundred-calorie portions a week. This would be about 114 a day. The number of hundred-calorie portions needed by any family can be estimated roughly by reference to the table given below. Such an estimate will provide a means for comparing the allowances for any given family with the allowances given in this bulletin for the average family. For illustration, suppose a family consists of one man who does little muscular work; two women, one of whom does little muscular work, the other hard muscular work; an active boy 16 years of age, and three children, 11, 8, and 4 years of age. These persons would require, respectively, about 200, 150, 200, 280, 140, 120, and 100 hundred-calorie portions a week, which make a total of about 1,200 hundred-calorie portions, or 50 per cent more than that needed by the average family. All of the allowances given in this bulletin, therefore, would have to be increased by half. The medium cereal allowance would then be about 22 pounds a week instead of 15, the medium fat allowance 6 instead of 4 pounds, and so on through the groups.

Energy needs of different individuals.

[Hundred-calorie portions.]

Individual.	Per day.	Per week.
The average person over 12 years of age	27	200
A man or boy using much muscular energy in work or play	40	280
A man or boy using little or no muscular energy in work or play	27	200
A woman or girl using much muscular energy in work or play	27	200
A woman or girl using little or no muscular energy in work or play	22	150
A boy or girl between 10 and 12 years of age, at least	20	140
A boy or girl between 6 and 9 years of age, at least	17	120
A boy or girl between 2 and 5 years of age, at least	14	100

The above amounts represent the gross allowance which should be made in the family food supply for the different individuals described, and provide for some waste. The amount actually eaten is usually 5 to 10 per cent less than the amount supplied.

CUTTING DOWN THE COST OF A WEEK'S FOOD SUPPLY.

The amounts of foods given in the preceding part of this bulletin (namely, 70 pounds of vegetables and fruits, fresh weight, or 160 hundred-calorie portions of vegetables and fruits, fresh, canned, and dried; 14 quarts, or 84 hundred-calorie portions of milk; 10½ pounds, or 84 hundred-calorie portions, of flesh foods, eggs, and cheese; 15 pounds of cereal, dry weight, or 240 hundred-calorie portions of cereal foods; 4½ pounds of sugar, or 80 hundred-calorie portions of sweets; and 4 pounds of fat, or 160 hundred-calorie portions of fat foods) may be depended on to supply enough fuel for the average family per week and to make an attractive diet. For economy's sake, however, it is often necessary to take into account the separate as well as the average values of the foods of the different groups. The following table is therefore given to show the fuel values in terms of approximate hundred-calorie portions of many of the common food materials as purchased:

Approximate number of hundred-calorie portions in common food materials.

GROUP I. VEGETABLES AND FRUITS.

Materials.	Number of hundred-calorie portions.	Materials.	Number of hundred-calorie portions.
Vegetables, fresh:		Vegetables, canned—Continued.	
Asparagus	1 per pound.	Tomatoes	1 per pound.
Beans, lima, shelled	5½ per pound.	Do	1¼ per No. 2 can.
Do	7 per quart.	Peas	2½ per pound.
Beans, string	1¾ per pound.	Do	3 per No. 2 can.
Do	1½ per quart.	Vegetables, dried:	
Beets	1½ per pound.	Beans	15½ per pound.
Cabbage	1 per pound.	Cowpeas	15½ per pound.
Do	3 per medium-sized head (3 pounds).	Peas	16 per pound.
Carrots	1½ per pound.	Fruits, fresh:	
Cauliflower	1½ per pound.	Apples	2 per pound.
Do	2 per medium-sized head (1½ pounds).	Do	24 per peck.
Celery	¾ per pound.	Bananas	3 per pound.
Corn	1¼ per pound.	Do	11 per dozen medium-sized.
Do	11 per dozen medium-sized ears.	Cherries	3½ per pound or per quart.
Cowpeas, shelled	6 per pound.	Cranberries	2 per pound or per quart.
Cucumbers	¾ per pound.	Currants	2½ per pound or per quart.
Do	¼ per medium-sized cucumber.	Grapes	3½ per pound or per quart.
Lettuce	¾ per pound.	Huckleberries	3½ per pound or per quart.
Do	¼ per medium-sized head.	Lemons	1½ per pound.
Mushrooms	2 per pound.	Do	4½ per dozen medium-sized.
Okra	1½ per pound.	Muskmelon	1 per pound or 1 per medium-sized.
Onions	2 per pound.	Oranges	1¾ per pound or 10 per dozen medium-sized.
Parsnips	2½ per pound.	Peaches	1½ per pound, 6 per dozen.
Peas	2½ per pound.	Pears	2½ per pound.
Do	20 per peck.	Plums	3¾ per pound.
Potatoes, Irish	3 per pound.	Raspberries	3 per pound or per quart.
Do	45 per peck.	Strawberries	1¾ per pound or per quart.
Potatoes, sweet	4½ per pound.	Watermelon	½ per pound.
Do	63 per peck.	Fruits, canned:	
Pumpkin	½ per pound.	Cherries	4 per pound.
Radishes	1 per pound.	Do	5 per No. 2 can.
Rhubarb	¾ per pound.	Peaches	2 per pound.
Spinach	1 per pound.	Do	2½ per No. 2 can.
Do	5 per peck.	Pears	3½ per pound.
Squash	1 per pound.	Do	4½ per No. 2 can.
Tomatoes	1 per pound.	Pineapples	7 per pound.
Turnips	1¼ per pound.	Do	4½ per No. 2 can.
Turnip tops	2 per pound.	Fruits, dried:	
Vegetables, canned:		Apples	13 per pound.
Beans, string	1 per pound.	Dates	14 per pound.
Do	1¼ per No. 2 can.	Figs	14½ per pound.
Beans, baked	6 per pound.	Prunes	11½ per pound.
Do	7 per No. 2 can.	Raisins	14 per pound.
Corn	4½ per pound.	Fruits, miscellaneous:	
Do	6 per No. 2 can.	Olives, green or ripe	10 per pound or per pint.

Approximate number of hundred-calorie portions in common food materials—Continued.

GROUP II. FOODS DEPENDED UPON FOR EFFICIENT PROTEIN.

Materials.	Number of hundred-calorie portions.	Materials.	Number of hundred-calorie portions.
Dairy products:		Fish, fresh:	
Milk, whole	3 per pound or 6 per quart.	Bass	2 per pound.
Milk, skim	3 per quart.	Codfish	1½ per pound.
Buttermilk	3 per quart.	Halibut, steak	4½ per pound.
		Mackerel, Spanish	3½ per pound.
Milk, condensed, unsweetened	6½ per pound or per quart.	Perch	2 per pound.
		Salmon	6 per pound.
Milk, powdered, whole	23 per pound.	Shad	3½ per pound.
		Shad roe	6 per pound.
Milk, powdered, skim	16 per pound.	Smelts	2¼ per pound.
Cheese, ordinary	19½ per pound.	Trout, brook	2¼ per pound.
Cheese, cottage	5 per pound.	Fish, smoked or salted:	
Eggs	9 per dozen.	Cod, salt (boneless)	5 per pound.
Meats	9 per pound.	Halibut, smoked	9 per pound.
Beef, average	10 per pound.	Herring, smoked	7½ per pound.
Beef, chuck	7½ per pound.	Mackerel, salt	10 per pound.
Beef, corned	12½ per pound.	Fish, canned:	
Beef heart	13 per pound.	Salmon	6½ per pound.
Beef liver	5½ per pound.	Sardines	9 per pound.
Beef ribs	11 per pound.	Tuna fish	9½ per pound.
Beef, round	7¼ per pound.	Shellfish, fresh:	
Beef, sirloin	9½ per pound.	Lobster	1½ per pound.
Beef tongue	5½ per pound.	Oysters	2 per pound.
Lamb, average	10 per pound.	Do.	4 per quart.
Lamb, leg	11 per pound.	Scallops	3½ per pound.
Lamb, loin	13 per pound.	Shellfish, canned:	
Mutton, average	12 per pound.	Lobster	4 per pound.
Pork, average	22 per pound.	Shrimps	5 per pound.
Pork, ham	16 per pound.	Legumes:	
Veal, average	5½ per pound.	Peanuts, unshelled	19 per pound.
		Peanuts, shelled	11 per quart.
Poultry:		Do.	25 per pound.
Chicken, broilers	3 per pound.	Peanut butter	27½ per pound.
Fowl	7½ per pound.	Soy beans, dried	20 per pound.

GROUP III. CEREAL FOODS.

Materials.	Number of hundred-calorie portions.	Materials.	Number of hundred-calorie portions.
Bread	12 per pound.	Macaroni	16 per pound.
Do.	9 per loaf, 16 oz. dough, 12–14 oz. baked.	Oatmeal	18 per pound.
		Rice	16 per pound.
Cereals, flaked	15 per pound.	Rolls	12 per pound.
Corn meal	16 per pound.	Rolls, 2–ounce size	18 per dozen.
Crackers	19 per pound.	Tapioca	16 per pound.
Flour, wheat	16 per pound.	Wheat, shredded	16½ per pound.
Flour, buckwheat	16 per ponnd.		

GROUP IV. SUGARS AND SUGARY FOODS.

Materials.	Number of hundred-calorie portions.	Materials.	Number of hundred-calorie portions.
Candy, average	17 per pound.	Sirup, corn	54 per quart.
Honey	15 per pound.	Sirup, maple	49 per quart.
Do.	55 per quart.	Sugar, granulated	18 per pound.
Molasses	13 per pound.	Sugar, maple	15 per pound.
Do.	50 per quart.	Chocolate, milk	22½ per pound.
Sirup, corn	14½ per pound.	Chocolate, sweet	22 per pound.

GROUP V. FATS AND FAT FOODS.

Materials.	Number of hundred-calorie portions.	Materials.	Number of hundred-calorie portions.
Fats, table and cooking:		Nuts—Continued.	
Butter	34 per pound.		
Lard	41 per pound.	Butternuts, unshelled	4 per pound.
Oil	41 per pound.	Butternuts, shelled	32 per pound.
Suet	34 per pound.		
Cream, 18 per cent	9 per pound or per pint.	Coconut in shell, without milk	14 per pound.
Cream, 40 per cent	17 per pound or per pint.		
Fat meats:		Hickory nuts, unshelled	12 per pound.
Bacon	26 per pound.		
Pork, salt	28½ per pound.	Hickory nuts, shelled	33 per pound.
Pork sausage	21 per pound.	Pecans, unshelled	17 per pound.
Nuts:		Pecans, shelled	33 per pound.
Almonds, unshelled	16 per pound.		
Almonds, shelled	29 per pound.	Walnuts, California, unshelled	8½ per pound.
Brazil nuts, unshelled	16 per pound.	Walnuts, California, shelled	32 per pound.
Brazil nuts, shelled	32 per pound.	Chocolate	28 per pound.

From the figures in the table and from the market prices of foods, the cost of a hundred-calorie portion of any food can be determined, and the cost of the various foods that serve the same purposes in the diet can be compared.

Take, for example, ordinary cheese, which provides 19 hundred-calorie portions per pound, and average beef, which provides 10 hundred-calorie portions per pound. When cheese sells for 38 cents a pound it costs 2 cents per hundred-calorie portion, and beef of average composition would have to sell for 20 cents a pound to be equally cheap as a source of energy. Bread, which furnishes 12 hundred-calorie portions per pound, costs about 1 cent per hundred-calorie portion when it sells for 12 cents a pound or for 9 or 10 cents per ordinary baker's loaf. To provide energy as cheaply, ready-to-eat breakfast cereals, which yield about 16 hundred-calorie portions per pound, would have to sell for 16 cents a pound or for 5 cents for an ordinary 5-ounce package.

It is often possible, too, to save money by changing the proportions of the foods from the average groups, and such changes are safe within certain limits. With the exception of the milk for children, the foods of any group may safely be increased or decreased by 50 per cent, and sweets may be omitted altogether, if desired. Under most conditions of living the cheapest foods are the lower-priced cereal preparations, namely, flour, meal, and bread. Flour and meal seldom cost more than one-half cent per hundred-calorie portion, and baker's bread seldoms costs more than 1 cent per hundred-calorie portion. One of the most satisfactory ways of reducing the cost of the diet, therefore, is by increasing the amount of cereal foods to 22½ pounds a week for the average family, or until they supply 45 per cent of all the fuel. When this is done, a few precautions must be observed. Care must be taken in the preparation of the cereals so that they will be palatable, and wisdom must be used in the selection of other foods. At least, some of the cereals should be of the kind made from the whole grain, and the extra allowance of cereal foods must never be at the expense of milk or green-leaf vegetables. In general, too, extra care must be taken to select savory or flavorful foods from other groups when for economy's sake a comparatively large part of the diet is made up of cereals.

In figuring the relative costs of foods it must be remembered that a small saving per hundred-calorie portion may amount to considerable in the course of a week. For example, the 800 hundred-calorie portions usually consumed by the average family per week will cost $16 if the average price paid is 2 cents per hundred-calorie portion. If the average price can be reduced to 1½ cents per hundred-calorie portion the cost of the week's food supply will be $12 instead of $16, a saving of $4.

SUGGESTIONS FOR A HOUSEHOLD FOOD-ACCOUNT BOOK.

If the household food-account book is so arranged that the items of the different groups are kept separate, it is easy to see whether the food supply is well proportioned and also to estimate the amounts of food used. Under each group there should be several subheads. For example, under vegetables and fruits, there should be at least two, one for fresh and canned, the other for dried. This will serve as a reminder that the original or fresh weight of the dried fruits was six times their dried weight, and that therefore 1 pound dried represents 6 pounds fresh weight. Most housekeepers will wish also to record separately fresh, canned, and dried vegetables, and fresh, canned, and dried fruits. In addition to this, it is well to list the green-leaf vegetables separately as a reminder of their importance in the diet. The section of the account book devoted to vegetables and fruits would then be arranged somewhat as shown below, and this would be typical of other groups as well.

HOUSEHOLD FOOD ACCOUNT BOOK.

GROUP I.—*Vegetables and fruits.*

FRESH GREEN-LEAF VEGETABLES.

Date.	Kind.	Amount.	Weight.	Cost.
Total				

OTHER FRESH VEGETABLES.

Total				

CANNED VEGETABLES.

Total				

GROUP I.—*Vegetables and fruits*—Continued.

DRIED VEGETABLES.

Date.	Kind.	Amount.	Weight.	Cost.
Total				

FRESH FRUITS.

Total				

CANNED FRUITS.

Total				

DRIED FRUITS.

Total				

Under Group II there should be at least two subheads, namely, (1) milk, and (2) eggs, cheese, and flesh foods. For convenience, however, the number of such foods may be increased to make separate records for milk; buttermilk and skim milk; eggs; fresh fish, dried fish, canned fish, meat, poultry, cheese, and peanuts.

Under Group III there should be at least two heads, namely, (1) dry cereals and (2) bread and rolls. This divides the foods that contain only three-fourths of cereal per pound from those that are all cereal. For convenience, a third subhead may be used, namely, (3) other bakery goods. These last-mentioned foods, which include cake, pie, doughnuts, and crackers, usually contain some fat and sugar, which raise their fuel value. They correspond more closely, therefore, in fuel value to the cereals themselves than to bread.

Under Group IV there should be three heads, namely, (1) sugar and candy, (2) honey, molasses, and sirups, each pound of which corresponds with about three-fourths of a pound of sugar, (3) jams, jellies, and preserves, each pound of which corresponds to about half a pound of sugar.

Under Group V there should be four heads, (1) fats, (2) bacon, salt pork, pork sausage, fat nut meats, chocolate, each pound of which corresponds to about three-fourths pound of fat, (3) butter and other table fats, each pound of which corresponds to about 13 ounces of fat, and (4) cream and nuts in the shell, each pound of which corresponds to about one-fourth of a pound of fat.

With this arrangement it is possible to estimate quickly the number of quarts of milk used and also the number of pounds of vegetables and fruits, fresh weight, of meats and similar foods, of cereals, of vegetables, and of fat. With this arrangement, too, the number of hundred-calorie portions used can easily be estimated with sufficient accuracy for most purposes. This can be done by allowing 2¼ hundred-calorie portions per pound for the fresh vegetables and fruits; 13½ per pound for the dried vegetables and fruits; 3 per pound or pint for the whole milk; 1½ per pound or pint for the buttermilk and skim milk; 8 per pound for the eggs, cheese, and flesh foods; 16 per pound for the dry cereals, and also for pies, cakes, and crackers; 12 per pound for bread; 18 per pound for sugar and candy; 13½ per pound for sirups; 9 per pound for jellies, jams, and marmalades; 40 per pound for fats; 34 per pound for butter; 30 per pound for bacon, etc.; and 9 per pound for cream and nuts in the shell.

Those who wish to compare the cost per hundred-calorie portion of different foods or to calculate the number of hundred-calorie portions provided for each separate food should add two more columns to the account. A sample section of the account book would then be arranged as follows:

GROUP II.—*Eggs, cheese, and flesh foods.*

Date.	Kind.	Amount.	Weight.	Cost.	Number of 100-calorie portions.	Cost per 100-calorie portion.
Total.						

SUMMARY.

The problems of food selection considered in this bulletin come under four heads, namely, adequacy, wholesomeness, attractiveness, and cost. Of all the many food materials now available there is not one that can not be made to contribute in some way to the wholesomeness or to the attractiveness of the diet, but the number of different kinds of foods actually needed is small. All the food materials may in fact be classed under five heads or groups. Some of the members of each of the groups are shown in the illustrations on pages 9 to 16 in such quantities that, taken together, they make a weekly food supply for an average family, consisting of a father, a mother, and three young children. Most of the common food materials that are not shown in the illustrations are included in the lists on pages 9 to 16, or mentioned in other parts of the bulletin. Since no two materials, even those that are grouped together, serve exactly the same purposes in the diet, attention is called to certain exceptionally important foods under each group that must not be omitted for any long period of time.

The grouping recommended brings together under one head those foods which serve some, at least, of the same purposes in the diet, and which can therefore be reasonably compared in price. Accordingly, when economy is concerned it is necessary only to compare the foods of a given group with reference to the amount of nourishment they provide for a given sum of money. The amount of nourishment or of material other than water and inedible substances in a pound of each of the different foods is stated in two ways, by weight and by hundred-calorie portions. By means of either of these two methods of measuring food values the amount of nourishment obtained for a given sum of money in buying different foods at different market prices can be estimated and compared.

Suggestions are made for adapting the allowance of foods to the needs of families that require more or less food than the average family, and also for changing the proportions of the diet in the interest of economy.

NOTE.—Reproductions, in black and white, 18 by 24 inches, of the eight Food Selection and Meal Planning Charts described on page 4 of this bulletin, may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 50 cents a set.

How To Do It

DO YOU want practical suggestions on how to build a silo, a hog house, a poultry house, a potato-storage house, or how to make a fireless cooker, or other farm home convenience? Are you seeking ideas on how to prepare vegetables for the table, how to care for food in the home, how to bake bread and cake and other appetizing foods in an efficient and economical manner? Is there some practical question about your corn or wheat or cotton or other crops, or about your poultry or live stock, to which you are seeking an answer? The answers to thousands of such questions and practical suggestions for doing thousands of things about the farm and home are contained in over 500 Farmers' Bulletins, which can be obtained upon application to the Division of Publications, United States Department of Agriculture, Washington, D. C.

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UNITED STATES DEPARTMENT OF AGRICULTURE

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Utilization of
ALFALFA

PUBLICATIONS RECOMMENDED FOR REFERENCE IN CONNECTION WITH THIS BULLETIN.

The following publications regarding the subjects treated in this bulletin will be sent free of charge upon application to the Department of Agriculture, Washington, D. C.:

Alfalfa. Farmers' Bulletin 339.
Growing Hay in the South for Market. Farmers' Bulletin 677.
Commercial Varieties of Alfalfa. Farmers' Bulletin 757.
Irrigation of Alfalfa. Farmers' Bulletin 865.
Haymaking. Farmers' Bulletin 943.
Curing Hay on Trucks. Farmers' Bulletin 956.
Hay Caps. Farmers' Bulletin 977.
Labor-Saving Practices in Haymaking. Farmers' Bulletin 987.
The Development of the Peruvian Alfalfa Industry in the United States. Department Circular 93.

UTILIZATION OF ALFALFA.

R. A. OAKLEY and H. L. WESTOVER, *Agronomists, Office of Forage-Crop Investigations.*

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A NEARLY PERFECT FORAGE.

NO FORAGE CROP cultivated in the United States is utilized successfully in so many ways as alfalfa. It is more nearly a perfect forage than any other crop grown in this country. As hay it is unsurpassed for general feeding. As pasture it has a high carrying capacity and produces large gains. As a soiling crop it is valuable with proper handling. It makes excellent silage and when ground into meal is a good and easily handled feed. Alfalfa is so highly regarded as forage that attempts have been made to introduce it into the realm of human food and medicine. There, however, it is out of place. It can not compete as food with other staple crops, and, so far as known, it possesses no special medicinal properties.

Alfalfa is not alone valuable as a forage crop but also produces a favorable effect on the succeeding crops, and because of this is generally regarded as a soil improver. It does not lend itself well to short rotations, but, other conditions being favorable, good yields of intertilled crops are produced on fields that have been in alfalfa for a few years.

MAKING ALFALFA HAY.

A great proportion of the alfalfa of the country is utilized as hay. The number of cuttings obtainable from a field in a year depends upon the variety and the length of the growing season and varies from eight, or occasionally more, in the extreme Southwest, to two, or sometimes only one, in the northern and semiarid sections. From 30 to 40 days of good growing weather are usually required to produce sufficient growth for a hay crop.

TIME OF CUTTING ALFALFA.

The proper time to cut alfalfa is a subject upon which there is conflicting opinion. Chemical analyses have shown alfalfa cut in early bloom to be slightly higher in protein than that cut when more mature. Certain farm animals, such as hogs and cattle, have a preference for it when cut at the earlier stages. Partly because of these facts and also because it was believed that the more frequent cuttings gave larger total yields, the earlier writers on alfalfa recommended cutting just before the flowers appeared.

Experiments soon proved that such early cuttings reduce the longevity of the stand, and while yields are usually greater the first season they are much less over a period of years. The later recommendation was that the alfalfa be cut when the basal shoots were 1 or 2 inches long, or when the plants are one-tenth in bloom. The two guides as to proper stage for cutting seem to be needed, as basal shoots usually make little growth in dry weather and blossoms are slow to appear during wet periods.

In view of recent experiments, particularly those conducted by the Kansas Agricultural Experiment Station, it would seem that cutting at a later stage is generally more satisfactory. That station for several years compared cutting at four stages, viz, in bud, one-tenth in bloom, full bloom, and when seed pods were forming. In feeding value the earliest cutting was highest, but the stand was practically destroyed in one season. Cutting when one-tenth in bloom gave less hay than when in full bloom; moreover, grass and weeds soon began to appear in the plat. Cutting when the seed pods were forming gave less hay than earlier cuttings, but the stand was not injured. No damage resulted from cutting the basal shoots, in spite of the fact that writers generally have emphasized the necessity of harvesting before such shoots are tall enough to be cut by the mower. Similar results have been obtained in experiments conducted by the United States Department of Agriculture.

Where winterkilling is a factor the last cutting of the season should take place early enough to allow for a growth of at least 6 to 8 inches for winter protection; otherwise serious injury is likely to result.

In the Great Plains region, where the rainfall is rather limited, stands of alfalfa are sometimes seriously depleted when the first cutting is delayed until the plants are nearly through blooming. The injury is likely to be more serious where a second cutting is made or where the alfalfa is left for seed. This is particularly true in dry seasons when the soil does not contain sufficient moisture to produce any appreciable growth after cutting. It must be borne in mind that cutting is harmful rather than beneficial to the plants.

CURING ALFALFA.

The methods of harvesting alfalfa for hay vary considerably in different parts of the country. The aim is to get the hay into the stack or barn with as large a proportion of the leaves as possible. The best way to do this is to let most of the curing take place in the cock. However, this system entails a greater amount of labor, and as more time is required the hay is subjected to greater danger of damage by rain. When a farmer has a large acreage to handle it becomes necessary to do the work in the most rapid and economical manner possible. In most of the big alfalfa-growing sections of the West rains are less frequent at harvest time and curing presents fewer difficulties than in the East. In good drying weather the general practice in the West is to mow in the morning, rake in the afternoon or on the following morning as soon as the dew is off, and then bunch with the rake or leave the hay to cure in the windrow. If the growth is not too heavy the hay should be ready to stack by the second afternoon. In the East, where rains are of such frequent occurrence, it is sometimes necessary to do much of the curing in the cock; but where the weather promises to be fair for two or three days it is usually advisable to hasten the process by doing much of the curing in the windrow even at the sacrifice of some of the leaves. If the hay is exposed to unfavorable weather for several days even though cocked, the resulting loss is very likely to be greater than would result from shattering by more rapid curing.

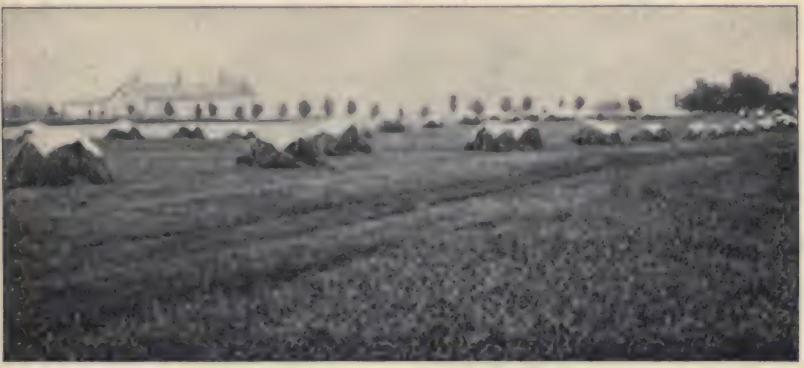

FIG. 1.—Hay caps used in curing alfalfa.

To hasten the drying of the hay and avoid damage by rain, several devices are used in humid sections. Hay caps, ordinarily consisting of a piece of canvas 3 feet square with a weight at each corner, are of considerable assistance in making a good quality of hay during unfavorable weather (fig. 1). To what extent their use is economical can not be stated definitely. Various forms of curing frames or tripods have been successfully used (fig. 2). One of these frames is described in detail in Farmers' Bulletin 677, entitled "Growing Hay in the South for Market."

Another device that is sometimes used is the curing truck, which is quite similar to the ordinary hayrack. It is approximately 12 feet long and 7 feet wide and will hold from 1,500 to 2,000 pounds of cured hay. The rack is supported by two 16 to 20 inch wheels placed about 4 feet from the rear end of an A-shaped frame. The front end is supported by a 6 by 8 inch wooden block of sufficient length to hold the truck level when it is not being moved. The truck is moved by means of a 2-wheel running gear similar to the front running gear of a low-wheeled wagon. When the hay is nearly in the condition in which it ordinarily goes into the cock it is put on the truck to finish curing.

The objection to all these devices is the additional labor and cost involved, and the economy of using them is questionable where labor is scarce and materials high. Where labor is plentiful and materials cheap the better quality of the hay may compensate for the additional expense.

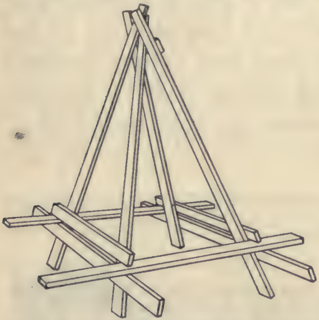
FIG. 2.—A curing frame that is sometimes used in curing hay in humid sections.

STORING AND STACKING.

The least loss of hay results when alfalfa is stored in the barn. It is frequently stated that the loss in hay stacked in the open is 10 per cent greater than in that stored in the barn. Much of this loss can be eliminated, however, by greater care in stacking and by covering the stack properly.

In the semiarid and arid sections of the West the losses due to weathering are much less than in the more humid sections. There many of the stacks are very carelessly built and are usually left uncovered. Notwithstanding the favorable climatic conditions, however, the loss in hay that remains in the stack for any considerable time is usually sufficiently heavy to more than equal the cost of time and labor involved in building a good stack.

Under humid conditions much greater care must be given to the building of stacks; otherwise the losses will be heavy. As the spoilage is proportionately less in large stacks the stacks should contain as much hay as practicable, and in order to shed water satisfactorily should be somewhat larger at the height of 6 feet than they are at the ground (fig. 3). The saving involved will ordinarily justify the additional cost of a protective covering, such as canvas, boards, or corrugated sheet iron (fig. 4). Where some such protection is not available the stack should be capped with grass hay, freshly cut slough grass, or Sudan grass. A load of green alfalfa placed on top will, on drying, form a good protection to the stack.

Alfalfa should not be put in the barn too green, as, like timothy, clover, or other hay, it is likely to heat, and in extreme cases to burn. However, the danger from spontaneous combustion can be lessened by the use of a boxlike ventilator, such as is shown in figure 5. This ventilator is 12 to 15 inches square and may be of any length desired. The corners are 2 by 4s and the crosspieces 1 by 3s placed close enough together to keep the hay from falling through and blocking the air passage. Braces are placed at intervals to prevent the box from collapsing under the pressure of the hay. The ventilators are usually placed across the mow at intervals of 7 or 8 feet. Where the mow is wide they are built in sections for convenience in handling. Figure 6 shows two of these ventilators in place.

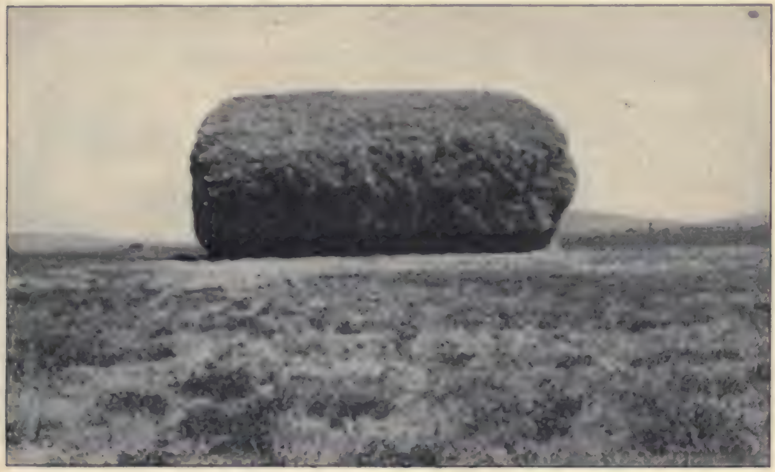

FIG. 3.—A well-built alfalfa haystack.

BALING ALFALFA.

Of the alfalfa that is baled, by far the greater part is baled from the stack or mow after the hay has gone through the sweat. When this stage has been passed there is practically no further loss, and on the basis of weight it makes little difference whether the hay is marketed immediately or several months later. However, in the arid and semiarid districts considerable baling is done from the windrow or cock. Though this practice is the most economical because of the smaller amount of handling required, it is generally less satisfactory from the feeder's standpoint. This is because the alfalfa is usually so dry before baling that it loses many leaves, and the feeding value of the hay is thereby reduced.

BROWN HAY.

When alfalfa is stacked before it is properly cured, that is, while it is only partially wilted or more or less green, chemical actions take place which result in changing the character of the hay. These changes involve change in color from normal green to shades of brown or black. They are for the most part the same or similar to those that take place in the silo. Their nature and extent depend very largely upon the percentage of moisture in the material when it is put into the stack or mow and the compactness with which it is stacked. A high percentage of moisture and relatively loose compacting or stacking in a small stack brings about charring or molding, resulting in a black or moldy product unfit for feed. If, however, the uncured hay is stacked properly with the requisite percentage of moisture, what is known as brown hay, having a pleasant odor, is produced.

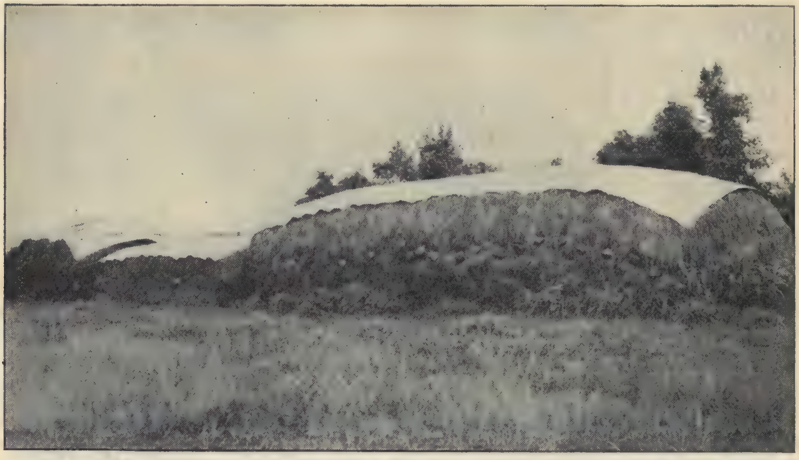

FIG. 4.—Stacks covered with corrugated sheet iron. These stacks are poorly built, but the covering will reduce the spoilage.

Much, if not most, of the brown hay is the result of accident rather than of definite intention; in fact, in a great many cases definite efforts to make brown hay have failed, and much loss has resulted.

The advantages claimed for brown hay are greater feeding value and the reduction of loss as a result of unfavorable weather for curing. As to the former, there are differences of opinion. Some farmers report excellent results from feeding brown hay; others have less satisfactory or adverse results. Good brown hay is very palatable to stock, but that it is superior to good field-cured hay in feeding value is very doubtful. Furthermore, there is evidence of actual loss of dry matter in making brown hay, even though the best methods are used. The experiments conducted by the Kansas Agricultural Experiment Station show this quite clearly and also that the loss is apparently increased with the length of time the hay is left in the stack and the degree of fermentation or organic change which it undergoes. The feeding tests with beef steers made by the Kansas Agricultural Experiment Station, in which brown and black alfalfa hay were tested in comparison with bright field-cured hay, indicate that good brown hay is as valuable as good green hay and that either is much superior to black hay.

The Wyoming Agricultural Experiment Station states that as a result of actual tests many farmers have satisfied themselves that brown hay is more palatable than bright or green field-cured hay and superior to it in feeding value for cattle and sheep. However, it is regarded by that station as being too dusty for horses.

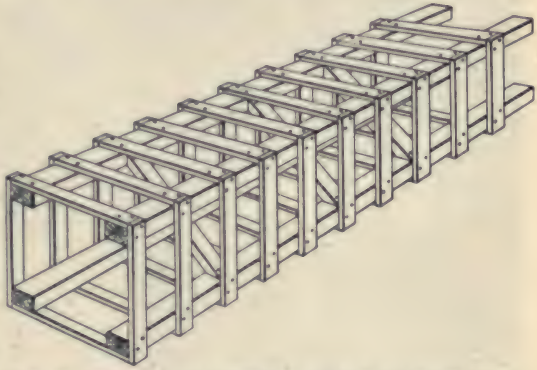

FIG. 5.—Box type of ventilator used in haymows to prevent spontaneous combustion.

From the reports at hand it is fairly concluded that good brown alfalfa hay is equal or somewhat superior in palatability to good field-cured hay, but not superior to it in feeding value.

Granted that the process by which brown hay is made does not make the hay more valuable, nevertheless the method involved would be important provided it could be depended upon for saving hay in humid climates, where satisfactory field curing is difficult. Such a method would enable the farmer to make good hay from his crop even if it contained a relatively high percentage of moisture.

Available experiments indicate that if external moisture is present on alfalfa—that is, if it is wet with rain or heavy dew—it can not be made into a good quality of brown hay. However, there seems to be no positive evidence in support of this contention. Because of the danger from spontaneous combustion, farmers are advised not to attempt to make brown hay in their barns or mows. If they wish to make it, they should use good-sized stacks, since it is difficult to bring about proper conditions for curing in small stacks.

FEEDING ALFALFA HAY.

Well-cured alfalfa is more readily eaten by all classes of farm animals than any other kind of hay. In feeding value it excels hay made from any of the grasses, and though chemical analyses do not show it to be any higher in the important constituents than certain other of the legumes, such as cowpeas, soy beans, and clover, the fact that alfalfa is generally more palatable gives it a somewhat higher feeding value. Several experiments have shown that good alfalfa hay is nearly, if not quite, equal to wheat bran, and when it is included in a ration the feed bill is reduced by doing away to a considerable extent with the necessity of purchasing protein feeds in the form of high-priced concentrates.

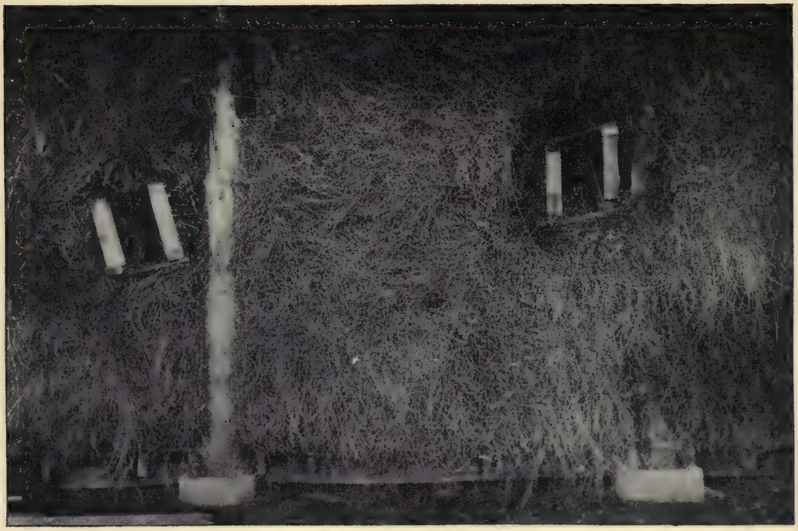

FIG. 6.—Ventilators in place in a hay barn.

Practically all farm animals show a preference for alfalfa hay cut in the early stages of growth, but this does not mean that such hay is always the best for feeding. On the contrary, certain animals, horses and mules in particular, do much better on hay made when the alfalfa is in full bloom, as the hay made at the early stages may be somewhat too laxative. Hogs and poultry can not handle such coarse material, and unless the alfalfa is cut while still young and tender considerable wastage in feeding will result.

ALFALFA HAY FOR BEEF CATTLE.

Alfalfa probably is the best roughage for fattening cattle. It is also very valuable for young stock. Fed alone, it is more than a maintenance ration, but it is wasteful to make it the only feed, as its narrow nutritive ratio results in an uneconomical use of protein. Cases of bloat have been reported from feeding alfalfa hay, but they are uncommon and generally traceable to overfeeding or to moldy or spoiled hay.

In comparing the value of certain roughages for wintering calves the North Platte experiment substation found that alfalfa hay gave much larger gains than prairie or sorghum hay. Half and half alfalfa and prairie hay or alfalfa and sorghum hay gave approximately the same gain as alfalfa alone, but much greater gains than either of the other roughages alone. In wintering yearling steers the results were quite similar; therefore it is concluded that some of the cheaper roughages can be used economically with alfalfa.

In an experiment conducted by the Nebraska Agricultural Experiment Station comparing various combinations of corn, alfalfa, corn silage, and cottonseed meal, the corn and alfalfa gave the best results. In another experiment conducted by the same station, comparing eleven rations for feeding beef calves, the one composed of alfalfa hay, corn silage, and corn gave the best and cheapest gains and the most profit. In these experiments it was shown that alfalfa hay as a source of protein was cheaper than cottonseed meal. In a further comparison of rations a combination of alfalfa and silage gave the largest and most profitable gains.

The Arizona Agricultural Experiment Station found that alfalfa hay as a supplement to silage was more satisfactory than cottonseed meal.

The Kansas Agricultural Experiment Station found that the profit was much greater in feeding steers with corn-and-cob meal and alfalfa hay than in feeding the meal with sorghum hay.

In numerous experiments the addition of alfalfa to a ration for fattening cattle or for young growing stock has resulted in the production of cheaper, better, and more profitable gains. Compared with hay made from sorghum and the grasses, alfalfa hay without exception has given the best gains, but compared with hay made from clover and certain other legumes there does not seem to be any great difference in results, although in many cases the animals apparently find the alfalfa hay somewhat more palatable.

ALFALFA HAY FOR DAIRY COWS.

Dairy cows require high-protein feeds to produce profitable flows of milk. These can be supplied by feeding nonleguminous roughage and various protein concentrates, but the latter are expensive and can be replaced to a considerable extent by various legumes. Alfalfa hay is especially suitable for this purpose. It is palatable, very easily digested, and has a cooling and laxative effect. The quantity of alfalfa hay that a cow will eat varies, but it is commonly estimated that a dry cow will eat 20 to 25 pounds a day and a milking cow 25 to 30 pounds.

The Kansas Agricultural Experiment Station found that butter fat could be produced somewhat more cheaply where alfalfa hay was included in the feed than where the rations were balanced with concentrates. In a comparative feeding test the Illinois Agricultural Experiment Station found alfalfa hay a little superior to wheat bran, while the Pennsylvania and Tennessee stations found it somewhat inferior. The Nebraska Agricultural Experiment Station concluded as the result of experiments that good chopped alfalfa hay was equal to wheat bran.

In California it is a common practice to feed cows almost entirely on alfalfa, either pasture or hay. Though an experiment conducted at the California Agricultural Experiment Station did not show any increased profit by the addition of barley to the ration, still it is believed that, in general, the practice is economical and has a favorable influence on the condition of the cows and calves.

The Ontario Agricultural College and Experimental Farm found that with alfalfa hay and silage a cow can maintain her milk flow on a very small corn-meal ration, and in cases of cows far advanced in lactation the meal ration may be omitted entirely without decreasing the milk flow.

In general when alfalfa replaces to a large extent the high-priced concentrates, the profits derived from milk and butter are increased. In all cases alfalfa has shown its superiority to grass hays. It is equal, if not superior, to hay made from any other legume, and the best alfalfa hay is only slightly inferior to wheat bran.

ALFALFA HAY FOR HORSES AND MULES.

Both horses and mules are fond of alfalfa, and when discretion is used in feeding they thrive on it exceedingly well. Instances are on record where work has been performed on alfalfa hay alone, but such a practice is not only wasteful but likely to result injuriously to the animals. To get the full benefit from the protein in the alfalfa, a small grain ration should be fed.

In a comparative test of alfalfa, Johnson grass, Bermuda grass, timothy, and lespedeza for mules, the Mississippi Agricultural Experiment Station found that alfalfa stood first in feeding value and cheapness of gains. As a result of experiments the Kansas Agricultural Experiment Station found that corn and alfalfa when properly fed gave the cheapest ration for work horses. Alfalfa hay proved to be more valuable as roughage than prairie or timothy hay, reducing the cost of the daily ration 25 to 35 cents when fed with corn and oats. The Illinois Agricultural Experiment Station reports that less grain was required with alfalfa than with timothy to prevent farm horses from losing weight. At the Utah Agricultural Experiment Station it was shown that horses could be maintained at less cost and in better condition on alfalfa than on timothy.

These experiments and others show conclusively that alfalfa is one of the best roughages for horses, in spite of the prejudice against feeding it that exists among farmers. Numerous cases are on record where alfalfa hay has formed for years the major portion of the ration for work horses without injurious effect. In most cases harmful results can be traced to overfeeding or to using spoiled hay. To feed most economically, horses that are at work should have 1 pound of hay a day per 100 pounds of live weight. The first cutting, being considerably coarser, is better for horses than the subsequent cuttings, which are inclined to be "washy."

Authentic instances are reported where horses and mules have eaten the stems and left the leaves of good alfalfa hay, but a satisfactory explanation of this has never been offered.

ALFALFA HAY FOR SHEEP.

Alfalfa hay is an excellent feed for sheep, either for breeding or fattening stock. Ordinarily the coarse and stemmy first cutting is not as good for sheep as the subsequent cuttings.

The New Mexico Agricultural Experiment Station was able to produce mutton of a quality suitable for local markets on alfalfa hay alone, but the addition of a little grain gave larger returns per acre of alfalfa hay, the cheapest gain being made on alfalfa hay and one-fourth of a pound of corn a day. More rapid gains, a shorter feeding period, and a better product resulted from the addition of grain. The Illinois Agricultural Experiment Station found that the most rapid gains were made when the proportion of corn was as great as the lambs could consume. With cheap corn such a ration gave the cheapest gains, but it is concluded that in feeding for profit the feeder must be guided to some extent by the relative prices of corn and alfalfa hay in determining the proper proportion of each. The Kansas Agricultural Experiment Station has been able to carry breeding ewes through the winter almost exclusively on alfalfa hay.

In general, though sheep may be kept in a very good condition on alfalfa hay alone, the addition of a little grain is advisable, both for breeding animals and for those being fattened.

ALFALFA HAY FOR HOGS.

Hogs are supposed to be so constituted that they can not economically digest dry hay or fodder, but there appears to be an exception to this in the case of alfalfa. Hogs do not eat alfalfa hay readily at first, but after becoming accustomed to it they relish a limited quantity, especially if it is made from plants cut at an early stage of maturity. However, as has previously been pointed out, there is danger of injuring the stand seriously by harvesting the alfalfa before it is well in bloom. To maintain a stand as long as possible it is necessary to sacrifice the palatability to some extent by delaying the cutting until a later stage.

Several State agricultural experiment stations have conducted experiments in feeding alfalfa hay to hogs. Practically all of them report very satisfactory results. In almost every case the addition of alfalfa hay to a grain ration reduced the cost of gains and improved the physical condition of the hogs. The North Dakota Agricultural Experiment Station found that when brood sows were fed alfalfa hay the grain ration could be reduced from one-third to one-fourth. When a one-fifth to one-sixth ration of alfalfa hay was fed with grain, considerable saving was effected in fattening hogs. At the Nebraska Agricultural Experiment Station brood sows were wintered on good alfalfa hay alone, but the results were more satisfactory where the animals received 1 pound of corn for every 100 pounds of live weight. As a result of another experiment conducted at this same station, alfalfa as a source of protein gave cheaper gains than tankage. Of several rations for fattening hogs that were compared none was equal to corn and alfalfa in the ratio of 9 to 1. At the Kansas Agricultural Experiment Station it was found that the gain on corn meal alone was more costly than where the hogs received alfalfa hay in addition to corn.

In several instances steamed hay has been compared with dry hay, and the general conclusion is that while the former gives somewhat larger gains, the gains are not sufficient to justify the additional expense of steaming. Practically the same conclusions have been reached in comparing ground and chopped alfalfa hay with unchopped hay.

Alfalfa is an ideal feed for brood sows, and there is less trouble with swine diseases when liberal quantities are fed.

PASTURING ALFALFA.

As far as palatability and carrying capacity are concerned, few plants excel alfalfa for pasturage. However, the crop should not be pastured the first year, and though it may be pastured lightly the second it is better to delay grazing until the third year, by which time the plants will have become more thoroughly established.

The advisability of pasturing alfalfa in the East at any time is open to question, as there is great danger of seriously injuring or destroying the stand unless extreme caution is used to avoid over-pasturing, grazing at an improper stage of growth, or grazing when the land is wet or frozen. The danger does not seem to be as great west of the ninety-seventh meridian, although even here due consideration should be given to these various points. While close grazing is injurious to alfalfa at any time, it is especially harmful in the late fall, since it leaves the plants in poor condition to go into the winter and results in whole fields being destroyed. Horses, mules, and sheep are more likely to injure alfalfa than are cattle or hogs, since they have a tendency to graze so closely as to injure the crowns of the plants.

When alfalfa is grazed regularly and closely, plants die, the stand thins out, and weeds come in. This condition can be obviated to a considerable extent by dividing the alfalfa field into several smaller fields and grazing the stock on each in succession. When the alfalfa is ready to cut for hay, enough stock is turned in to eat down the crop in a few days and then transferred to another field. Sometimes a field becomes too nearly mature before it is reached in the regular rotation, and then it is necessary to cut the crop for hay. Under the system of alternate grazing and resting, good stands have been maintained much longer than when the fields were continuously pastured.

Because of the danger in most parts of the country, and particularly in the humid sections, of losses from bloat, the advisability of pasturing alfalfa with sheep or cattle is open to question. This does not apply to horses, mules, or hogs, as no risk attends grazing them on alfalfa.

CATTLE ON ALFALFA PASTURE.

All classes of cattle do exceptionally well when grazed on alfalfa, out there is always more or less danger of bloat attending this practice. The danger is greatest in humid sections, but bloat may occur in any section, even under irrigation in the West, where a dry climate prevails. Some farmers who have pastured cattle on alfalfa for years have met with no difficulty, while others under conditions apparently the same have sustained heavy losses. Just why this is so has not been satisfactorily explained; in fact, the conditions that cause bloat are not well understood. Generally, the danger from bloat seems to be greatest when the alfalfa is young and tender. There are certain other conditions which experience seems to point to as inducing bloat, and as a result certain precautions are advised which it is thought will very greatly reduce the risk. Those generally recommended are: (1) Do not turn the cattle into the field when the alfalfa is wet with rain or dew; (2) let the animals feed on other forage, preferably hay, before turning them in on alfalfa; (3) allow the cattle to graze only a few minutes at a time until they have become accustomed to it, and then do not take them out of the field except for water; (4) sow some grass with the alfalfa, and have a patch of grass where the stock can graze on it at any time; (5) have a stack of hay or straw in the field, to which the cattle may have free access; and (6) have water and salt easily accessible to them.

If bloating occurs, there are various remedies that are more or less efficacious when employed in time. One commonly suggested is to drench the animal with a pint of raw linseed oil to which is added 4 tablespoonfuls of turpentine. Another treatment recommended is to drench with a one-half per cent solution of formalin made by adding 1 tablespoonful of formalin to 1 quart of water. These remedies may afford relief in the early stages, but when the case is well developed it is rarely that an animal can be saved except by the use of a trocar. It is always advisable to call a veterinarian when symptoms of bloat first appear, as farmers do not ordinarily have trocars or other means of treatment and are not sufficiently experienced to handle serious cases.

FIG. 7.—Dairy cows grazing on alfalfa.

Because of the danger of bloat, very few experiments have been conducted to determine the number of cattle a given area of alfalfa will carry, but it is generally estimated that 1 acre will support steadily two animals of approximately 900 pounds each for two months. The gains made by all classes of cattle on alfalfa pasturage, except where cases of bloat occur, are almost without exception highly satisfactory (fig. 7).

HORSES ON ALFALFA PASTURE.

No other pasture is equal to alfalfa for horses and mules. Work stock keep in good flesh and work well when fed a small quantity of grain daily in addition to alfalfa pasturage. It is especially good for mares and their foals. The Kansas Agricultural Experiment Station found that to get the greatest growth and development in horses it is necessary to feed some grain with alfalfa pasturage until the animals reach maturity.

Liverymen are prejudiced against alfalfa pasture for horses because of its laxative effect, and many claim that it stimulates the kidneys unduly. However, numerous cases are on record where alfalfa pasture has formed the major portion of the ration for working animals for a considerable time with no injurious results, and instances have been reported where horses have performed heavy work during the summer on nothing but alfalfa pasture. However, such feeding is not recommended for draft or driving horses.

SHEEP ON ALFALFA PASTURE.

Sheep are fond of alfalfa pasture and thrive on it if they do not bloat. The losses of sheep from bloat have been so great that in many parts of the country the practice of pasturing them on alfalfa has been discontinued. In the irrigated valleys of Arizona and California and some other sections of the West sheep are grazed regularly on alfalfa during the winters, but there are very few experimental data as to the carrying capacity per acre, the losses that may be expected, or the gains that can be depended upon.

The Colorado Agricultural Experiment Station, after collecting data from many large sheepmen, reached the conclusion that where the precautions that are recommended in pasturing cattle on alfalfa are followed, the loss of sheep can be kept down to 5 per cent, but where these precautions are not followed the losses usually run very high. This station recommended that only old ewes and their lambs be kept on alfalfa pasture, as they are less subject to bloat than young ewes or wethers. The carrying capacity of an acre is given at eight ewes and their lambs, from the middle of April to the first of October.

In the published report, "The Work of the Belle Fourche Reclamation Project Experiment Farm in 1915," it is stated that in the alfalfa-grazing experiments with sheep no bloating occurred. It is further claimed that sheep are successfully grazed on alfalfa by local stockmen, particularly in the late summer and early fall.

HOGS ON ALFALFA PASTURE.

In general, better results are obtained by pasturing alfalfa with hogs than with any other live stock. Hogs thrive on it and with proper precautions cause little injury to the stand. They do not trample the soil as much as heavier animals, and therefore, even in wet weather, do little damage. Everything considered, the results will be more satisfactory if the field is divided into two or more lots, so that the danger from overgrazing any portion of it may be reduced to the minimum. A practice commonly recommended as safe to follow, even in the Eastern States, is to limit the number of hogs per acre so that one or two cuttings of hay, depending on the section, may be secured during the season. Unless the fields are grazed down closely hogs usually will not do much rooting, but should they be inclined to root they may be prevented from doing so by ringing their noses.

While hogs will make some gain, alfalfa pasturage alone is barely more than a maintenance ration. To get them in condition for market it is therefore necessary to feed a small quantity of grain. With this combination hogs can be made ready for market cheaper than by means of any other feed. In a large number of experiments that have been conducted, a grain ration of 2 pounds for every 100 pounds of live weight has been found the most economical, but with a larger grain ration the gains are more rapid and the returns per acre somewhat higher. Generally speaking, the sooner a hog can be put in shape for the market the more profitable will be the returns, the more the chances of loss from cholera and other causes are reduced, and the smaller the interest on the investment. Furthermore, if the hogs are in good shape from the time they reach a weight of 200 pounds, the farmer is in a position to take advantage of the market conditions, that is, the hogs are always marketable and can be shipped when the price appears to be most satisfactory.

The carrying capacity of an acre of alfalfa depends upon the condition of the stand and varies with the locality. In the East, where the stand is more easily injured by overgrazing, it is not advisable to attempt to carry as many hogs to the acre as in the irrigated sections of the West. If grain is fed in connection with the pasture, an acre will, of course, support more hogs than if no grain is fed. Ordinarily, an acre of good alfalfa in any part of the country should carry 8 to 10 hogs weighing 100 pounds each with little danger of injury to the stand. Under the most favorable conditions an acre has been known to support twice this number, but such heavy grazing is very likely to prove harmful and can not be recommended except in cases where the field is soon to be plowed.

Experiments have shown some remarkable returns from grazing hogs on alfalfa. These returns run all the way from $50 to more than $150 per acre, but they are larger than can be reasonably expected under ordinary farm conditions, since due consideration was not given to risk of loss from disease and other causes and to overhead and carrying charges. Where alfalfa can be grown successfully, good returns may be expected from hogs pastured on it if a small grain ration is fed at the same time (fig. 8).

POULTRY ON ALFALFA PASTURE.

All kinds of poultry relish green alfalfa, and where hens have access to a field it has a very good effect in maintaining egg production. It is best to have the field divided, so that the fowls may be changed occasionally; otherwise the constant nipping back of the shoots will be detrimental to the plants. Even under the best system of management chickens have a tendency to keep the alfalfa eaten so closely on the portion of the field nearest their houses or coops that the plants are soon killed.

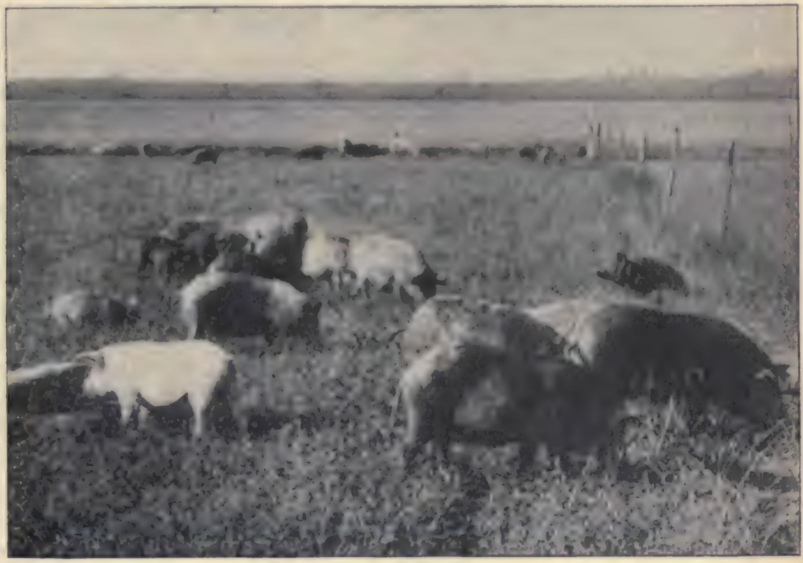

FIG. 8.—Hogs grazing on alfalfa.

ALFALFA AS A SILAGE CROP.

Alfalfa is used for silage only to a limited extent. There are several reasons for this which are worthy of consideration. Tonnage is one of the factors of first importance in selecting a silage crop. To be highly satisfactory for this purpose, a crop must produce a large yield per acre. This is one—and a very good—reason why corn is so popular. Where corn can be grown successfully other silage crops have difficulty in competing with it. Where corn can not be grown successfully other crops must necessarily be considered, but usually on the basis of the yield of green matter which they will produce. Alfalfa is outranked by corn and in many sections by the small grains and other forage crops in the yield of green matter produced at a single cutting. Under reasonably favorable conditions alfalfa can be made into hay at less expense than into silage, and the quality of forage it produces as hay is nearly equal to that produced by it as silage. The crop does not lend itself particularly well to silage making. It is somewhat difficult to cut with ordinary silage cutters and is difficult to pack properly in the silo. Furthermore, the silage that has been made from alfalfa under practical conditions has not been uniformly satisfactory. Some of it has been excellent and some has been unfit for use; that is, it has developed a bad odor and has become moldy or slimy. This happens in the case of many of the other legumes, the trouble being largely due to difficulty in packing the freshly cut material in the silo. In view of the high percentage of protein in alfalfa, special care is necessary in packing; otherwise too much air is present and putrefaction takes place instead of the proper fermentation.

Notwithstanding the unsatisfactory features in connection with the use of alfalfa as a silage crop, it is used to some extent for this purpose. When weather conditions are not favorable for the curing of hay, alfalfa may be put into the silo. Good ensilage can be made from partially wilted alfalfa provided it is cut fine enough by the silage cutter and is well packed in the silo. Where alfalfa is partially cured before being ensiled some external moisture may improve the silage, but experience indicates that a "washy" ensilage is likely to result where freshly cut alfalfa is put up while wet with rain. Furthermore, wet fields and bad weather interfere with the operations of silage making. Since the filling of a silo is usually done cooperatively by the farmer and his neighbors, it is not always possible or economical to handle partly cured hay in this manner. The filling of a silo is not as simple an operation as stacking hay or putting it in barns.

Alfalfa and corn mixed make good silage. The relatively high percentage of carbohydrates (sugar and starch) in the corn is conducive to the right kind of fermentation. For this reason mixing alfalfa with the sorghums or small grains is advantageous. The Kansas Agricultural Experiment Station found that crude molasses mixed with alfalfa improved the quality of the silage, since, like the crops just mentioned, it adds the sugar necessary for good fermentation. Preliminary experiments conducted by the United States Department of Agriculture indicate that good silage can be made by mixing alfalfa and the straw of any of the small grains, provided the mixture is made when the material passes through the silage cutter and water is added if necessary to make it pack properly.

In conclusion, alfalfa is not regarded as an ideal silage crop, and where conditions are favorable it is usually advisable to cure it for hay rather than to put it into the silo. However, it will make good silage when properly cut and packed, especially if mixed with corn or sorghums or the small grains. The feeding value of alfalfa silage is very high. With a knowledge of these facts the farmer should be able to judge for himself whether or not it will be to his advantage to put his alfalfa crop into the silo.

ALFALFA AS A SOILING CROP.

Alfalfa is sometimes cut and fed green, but notwithstanding the fact that this method of handling the crop has proved highly satisfactory the practice is confined largely to the dairy farms of the northeastern quarter of the United States. The Arizona Agricultural Experiment Station estimates that by utilizing alfalfa as a soiling crop 35 acres will carry 100 steers weighing 900 pounds each through the growing season, which is about double what could be expected from pasturage. In Canada it is claimed that the cost of producing pork is reduced 25 to 50 per cent when green alfalfa is fed with grain, as compared with grain alone.

The main objection to feeding alfalfa green is the extra amount of labor involved, although this is doubtless more than offset by the increased production per acre and the better condition in which the stands are maintained as compared with pasturing. The only precaution necessary is to cut the crop no earlier and no oftener than it would be cut for hay. No cases are recorded of alfalfa causing bloat when used as a soiling crop.

ALFALFA TEA.

From time to time articles have appeared in newspapers very highly recommending alfalfa tea as a feed for pigs and calves. The tea is made by pouring boiling water on the hay and allowing it to steep for a few hours or by stirring alfalfa meal into cool water and straining the mixture after it has stood several hours. In feeding, some grain is added to the tea. Several State experiment stations have conducted tests to determine the value of alfalfa tea.

The Wyoming Agricultural Experiment Station found that growing pigs receiving a grain ration consisting of one-half corn meal and one-half middlings mixed with alfalfa tea made better gains than where water replaced the tea, but the gains were hardly sufficient to justify the additional expense. In feeding alfalfa tea to calves the Kansas Agricultural Experiment Station obtained poor gains, and it seemed almost impossible to keep the calves from scouring. It appears, therefore, that about the only conclusion that can be drawn from the results of the actual experiments with alfalfa tea is that it does not give sufficiently good results to justify the extra labor involved in making and feeding it either to pigs or calves.

ALFALFA STRAW.

In the production of alfalfa seed the forage feature of the crop is of secondary consideration. Attention is focused on the seed crop, and practices are followed that give the best returns in quantity and quality of seed. Therefore it frequently happens that the straw, as the stems and leaves are commonly called after the crop is thrashed, is less valuable from a feeding standpoint than if an attempt were made to obtain the best forage possible without sacrificing the seed crop unduly. For example, when the crop is harvested, as soon as most of the seed pods are mature and while the plants still retain many of their green leaves, the straw is of higher feeding value than when the plants are left until the pods are entirely ripe and the leaves have fallen.

FIG. 9.—Work horses feeding on alfalfa straw.

Where forage is of more concern it is better to cut the crop while the stems and leaves are somewhat green, as the increased forage value of the straw more than offsets the loss due to immature seed. If the straw is from the first crop of the season it is likely to be coarser and have fewer leaves than if it is from the second or subsequent crops. It is therefore regarded as being less palatable. In some sections farmers prefer straw from the first crop, as it is likely to contain a larger proportion of grass than the later cuttings and is thought to be of higher feeding value. Of course, in some sections the season is not long enough for more than one crop.

Opinions differ greatly with regard to alfalfa straw. Some farmers think it is better when the crop is grown under irrigation, as it contains more leaves and consequently is more valuable as a forage. There seems to be little in this contention. Some think if the crop is stacked as soon as it is harvested more leaves are retained and the curing which takes place in the stack improves the quality of the stems. While this may be the case, there is no definite evidence in support of it.

Again, there are some who regard alfalfa straw as practically worthless for feed, but this is probably because their experience has been confined to a very poor grade of straw or straw that had become damaged by weather after thrashing. Most farmers, however, who have had considerable experience in feeding alfalfa straw estimate its value at one-third to one-half the value of good alfalfa hay, and ordinarily this is the basis upon which it sells. Its actual value depends upon the time it is cut, the manner in which it is handled, and the conditions under which it is grown.

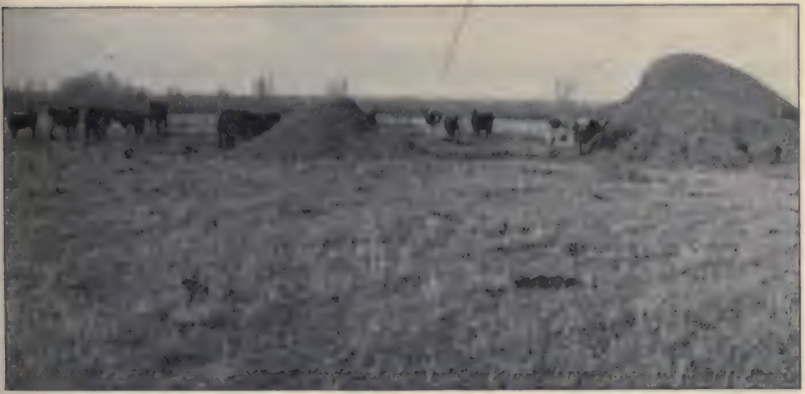

FIG. 10.—Cattle feeding on alfalfa straw in piles, a method that results in much waste.

Most of the alfalfa straw that is produced is fed to cattle, and in some cases cattle are carried through the winter on it with no supplemental feed. However, this practice is not to be recommended, for the straw, even when it is of good quality and eaten in large quantities, is barely a maintenance ration. Calves and old cows have difficulty in chewing it properly. It is not considered very satisfactory for dairy cows. Work horses and mules do very well on alfalfa straw if a liberal supplemental grain ration is fed, but more grain is required than with alfalfa hay (fig. 9). Sheep seem to do better on alfalfa straw than any other kind of farm animals, provided their teeth are in good condition.

In thrashing the alfalfa-seed crop, the stems and leaves are broken and pulverized more or less, depending upon the type of thrashing machine used and whether the material is passed through the machine one or more times. Unless care is taken in feeding it considerable waste results. Feeding directly from the stack is most unsatisfactory and wasteful, as the animals soon eat all of the fine material and leave the coarse stems until the last, which usually means that these are not eaten at all (fig. 10). If the straw is hauled from the stack and fed upon the ground a loss also ensues, particularly of the fine material. The most satisfactory method is to feed the straw in tight-bottom mangers, giving only enough for one feed at a time (fig. 11). In this way the fine material is not lost and very little of the coarse straw is wasted. Some care and judgment are necessary in feeding alfalfa straw to get the best results and at the same time avoid the loss of stock. The greatest source of danger in this connection is from compaction. When straw is fed alone the animals are forced to eat large quantities to get enough nutriment to meet their requirements. Under such conditions balls composed of dirt and fine particles of straw form in their stomachs, thereby blocking the passage between the stomach and intestines and very frequently causing death. This is not so likely to occur if the animals have access to salt and water at all times or if they have grain or pasture in addition. Cattle on pasture frequently seem to relish a certain amount of straw, but they will not eat large quantities of it unless compelled.

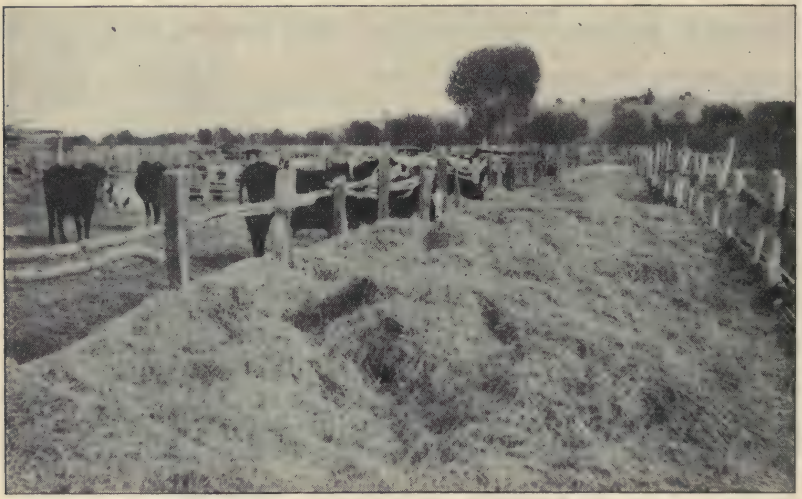

FIG. 11.—Cattle being fed alfalfa straw from mangers to avoid waste.

After all, the chief value of the alfalfa straw is that it furnishes some roughage, and the best results are secured when it is fed with a grain ration. Spoiled or moldy straw is very apt to result in derangement of the digestive tract, which sometimes proves fatal.

In times past alfalfa straw has been used very satisfactorily as a mulch in the citrus orchards of the Southwest. Its utilization for this purpose, however, is practicable only when the straw is cheap.

ALFALFA AS A GREEN MANURE, SOIL IMPROVER, AND ORCHARD COVER CROP.

As a rule alfalfa is not a satisfactory green-manure crop. Like many other perennials, it is rather slow to start and does not produce tonnage quickly enough. Furthermore, in many sections it is expensive and difficult to establish. From these various standpoints there are other crops that are so much more satisfactory for this purpose that alfalfa can not compete with them.

Where alfalfa has been grown on land for a series of years in regions of abundant rainfall or under irrigation it has a beneficial effect on the succeeding crops, with the possible exception of certain legumes, but under dry-farming conditions alfalfa frequently reduces the soil moisture to such an extent as to result in decreased yields of subsequent crops.

Where irrigation water is sufficiently abundant alfalfa as a permanent or partly permanent cover crop appears to be the best crop known for correcting certain soil troubles and the physiological diseases of fruit trees resulting therefrom. Its success in the West is causing it to be tried to some extent in apple orchards in the humid Eastern States. Some orchardists make a practice of removing at least one or two hay crops each season, leaving the remaining growth on the ground. On certain soils, particularly those of light texture, the results would doubtless be more satisfactory in the long run if the entire season's growth were left to maintain or increase the productivity of the soil. The arsenical sprays that are commonly used on fruit trees make caution necessary in connection with pasturage or the feeding of hay upon which the sprays have fallen.

ALFALFA MEAL.

The word meal as applied to ground or chopped alfalfa is misleading, since the material after it passes through the grinder is not of uniform consistency, but partakes more of the nature of chop than of meal. However, since the term alfalfa meal has become thoroughly established in the trade, the ground alfalfa will be referred to as meal in the succeeding pages.

There seems to be considerable uncertainty as to when and where the first alfalfa was ground into meal, but it is pretty well established that one of the first attempts to manufacture it on a commercial scale, if not the first attempt, was made at Wichita, Kans., about 1904. This attempt, while not particularly successful, attracted attention to the possibilities of developing an industry, and during the next few years several mills sprang up in various parts of the country. Among the factors contributing to the rapid development of the industry were the increase in the popularity of concentrated feeds, the extensive advertising campaign that was being conducted in the interest of alfalfa, and the desire to find a profitable outlet from the remote districts of the West.

Most of the early mills were built in Kansas and Nebraska, but many of these failed for one reason or another, and as new plants were established the industry moved westward, where the climatic conditions were more favorable and larger supplies of alfalfa were available. To-day the largest mills are found in Wyoming, New Mexico, California, and Colorado, the last-mentioned State surpassing in the number of mills and the output of meal. There are also numerous alfalfa mills in the cities of the Middle West, but they are practically always operated in connection with mixed-feed plants and use baled hay that has been shipped in from distant points.

One of the most important factors contributing to the unprofitable operation of alfalfa mills doubtless has been the failure to give sufficiently careful consideration to their location. In the eagerness to get in on the ground floor little or no attention was given to the probable effect of the climate in reducing the output by unfavorable weather, undependable supplies of hay and labor, and inadequate shipping and market facilities. The first grinding machinery made was not dependable, and fires were of such frequent occurrence, because of sparks caused by friction or the presence of pieces of metal in the hay, that considerable difficulty was encountered in getting insurance protection; consequently, when a plant burned it was difficult to get money for rebuilding. Promoters engaged in various schemes to sell stock without having any interest in the success of the plant after its completion, no consideration being given to location or to permanency of buildings and machinery. Furthermore, most of the pioneer mills were of such limited capacity that they could not be operated at a profit. These and other reasons account for many failures.

BUILDINGS.

In constructing buildings for alfalfa mills the desirable features are to have them cheap, durable, and as nearly fireproof as practicable. In most cases they are frame structures covered with corrugated sheet iron (fig. 12). The main building, which houses the machinery, is generally two or three stories high, has a cement floor, and is frequently of noninflammable material, to reduce the fire risk. For the same reason some millers express a preference for 1-story structures. Attached directly to this main building, or more commonly separated by a distance of 30 feet or more, are warehouses; usually one for receiving hay, with an average capacity of 50 to 100 tons of loose hay, and at least one for storing the meal, with a capacity ranging from a few hundred to four or five thousand tons. These structures are generally on opposite sides of the mill proper, although they are not uncommonly placed at right angles to each other, the arrangement depending largely upon the ground that is available. The floor in the hay warehouse is usually of cement, and sometimes the floor in the warehouse for the meal is of the same material. However, there seems to be some objection to the use of a cement floor in the meal warehouses, as the moisture in the cement rots the sacks and causes spoilage if the meal is left in contact with the floor for a considerable time. Men of experience, however, contend that the cement becomes thoroughly dry after two or three years and then the objection no longer holds. Spoilage from moist cement may be obviated by covering the floor with planks, but this of course increases the cost and fire risk. In addition to the buildings described above, there is nearly always a small building for the office and scales.

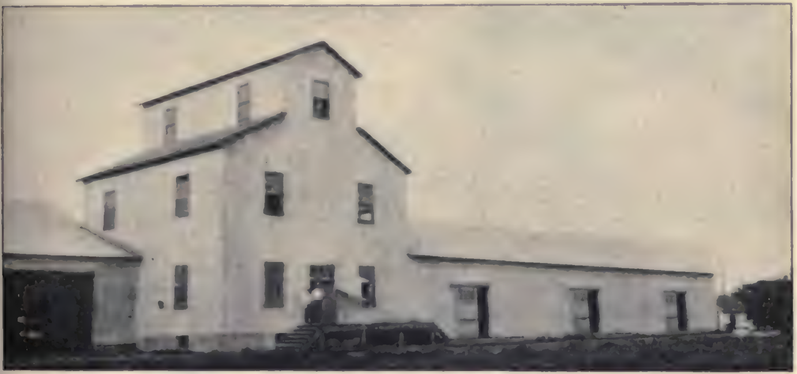

FIG. 12.—A typical alfalfa meal mill.

MACHINERY.

The essential machinery in a well-equipped mill consists of an electric motor, a steam or gasoline engine, a bale breaker, a grinder or pulverizer, screens, blowers, packers, cyclones and other dust collectors, wagons, conveyors, and scales. In addition, mills making mixed feeds are equipped with automatic feeders, sirup tanks, and mixing vats.

The power used in operating the mill depends largely upon what is available. In sections where electricity may be had most mills have two electric motors, one of 150 to 300 horsepower for running the grinder and another of 50 horsepower for running the fans and packers. Where electric power is not available steam or gasoline engines are used. Some millers who have both steam and electric power are of the opinion that steam power is cheaper, but the electric power is more convenient and involves less fire risk.

Mills that handle baled hay are equipped with bale breakers for breaking the bales apart before they are fed into the grinder.

Grinders or pulverizers are of various advertised capacities up to 12 tons an hour, but this high capacity is possible only under the most favorable conditions. In actual practice it is seldom safe to count on more than half the advertised capacity. The moisture content of the hay is very largely the determining factor. Strength is one of the prime requisites for a grinder, as the machinery is subject to a great strain, particularly when the hay is tough.

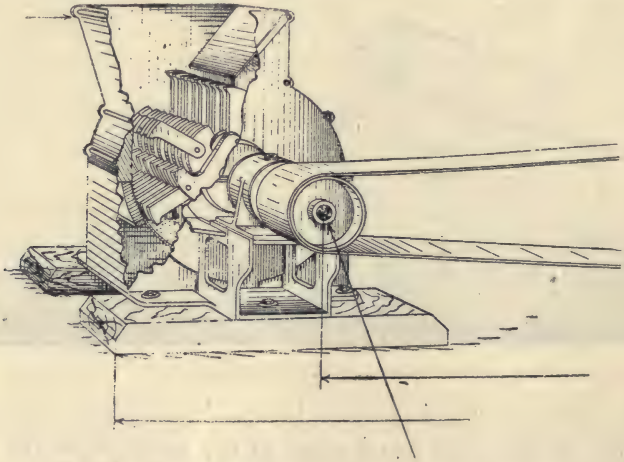

FIG. 13.—The swinging-hammer type of alfalfa grinder.

Grinders are made with two distinct objects in mind—one to reduce the alfalfa to small particles by breaking or grinding and the other to reduce it by cutting. The advantage claimed for the cutting machines is that the hay may be handled with more moisture and that the resulting meal is practically free from the dust that is objectionable from a feeding standpoint. However, most of the mills now in use depend upon the grinding or pulverizing principle. These mills are of four general types. One type consists of a large number of swinging steel hammers, which are fastened to plates of steel with three or four arms, each arm bearing a swinging hammer. The steel plates are fastened firmly to a revolving shaft (fig. 13). A modification of this type of machine consists of a series of heavy steel plates with two or four arms which are attached to a revolving shaft but have no swinging-hammer feature (fig. 14).

Another type of grinder has one or two series of hooked knives which partially cut the hay and force it into the main chamber, where it is further reduced by means of sharp-cornered steel pegs fastened to a rapidly revolving hollow drum (fig. 15).

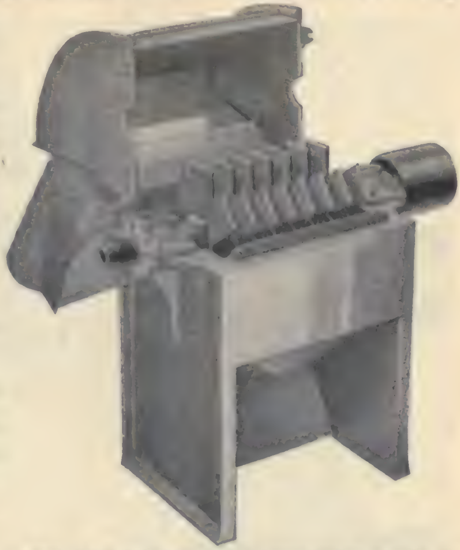

FIG. 14.—A machine for pulverizing alfalfa by means of square-cornered steel plates on a horizontal shaft.

One type of grinder is constructed on somewhat the same principle as a thrasher, but with the part that corresponds to the cylinder in several sections instead of in one piece. The teeth are much closer together, and all parts are necessarily greatly strengthened (fig. 16).

One of the machines that reduces the hay to meal by cutting works on practically the same principle as the ordinary ensilage cutter but has a special attachment for reducing the meal to a finer consistency (fig. 17).

Another machine that pulverizes the alfalfa by cutting is shown in figure 18.

All grinders are equipped with perforated steel plates or wire screens through which the meal passes when it becomes sufficiently fine. The size of these perforations or the mesh of the screens determines the fineness of the product (fig. 19).

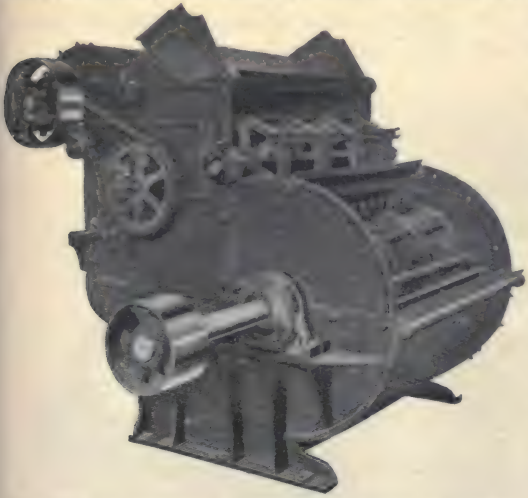

FIG. 15.—A machine for pulverizing alfalfa by means of a series of square steel pegs attached to a drum.

The blowers are large metal fans that produce the draft of air for conveying the meal from the grinders to the cyclones (fig. 20).

The cyclones (fig. 21) are hollow cones made of galvanized sheet iron and are located in the upper story of the higher buildings or where the building has only one story project through the roof. The purpose of these cyclones is to check the blast of air carrying the meal. The meal then drops through a galvanized tube to the packers.

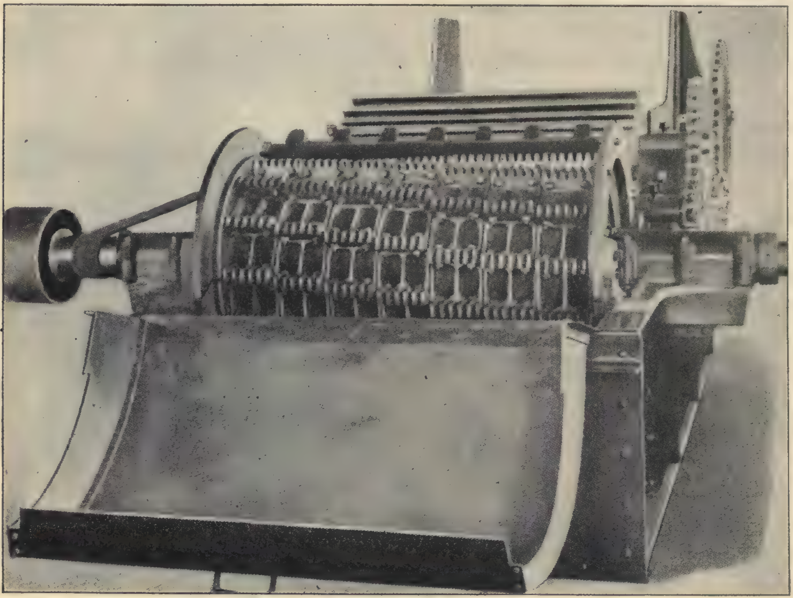

FIG. 16.—An alfalfa grinder with teeth arranged on a cylinder and concave similar to the ordinary thrasher.

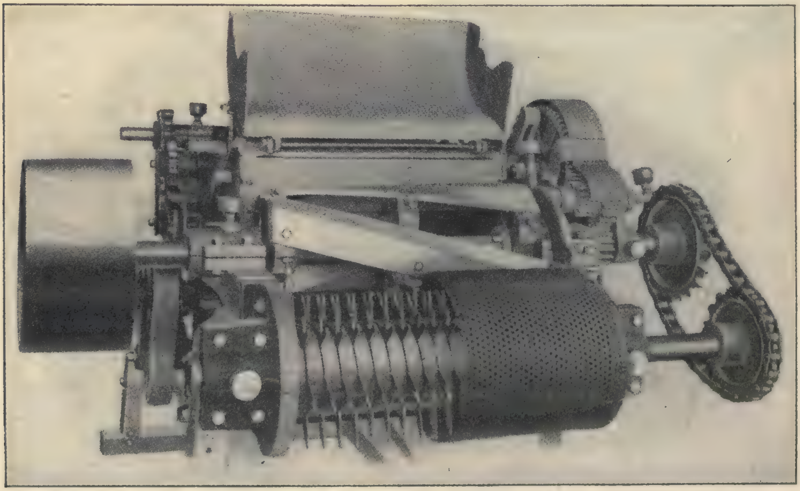

FIG. 17.—An alfalfa grinder in which the common feed-cutter principle is employed.

A few mills are equipped with automatic dust collectors, and while these do catch the finest particles of meal that are seen escaping as a green dust from the cyclones they apparently increase the fire risk, and for that reason most of the alfalfa mills do not have them.

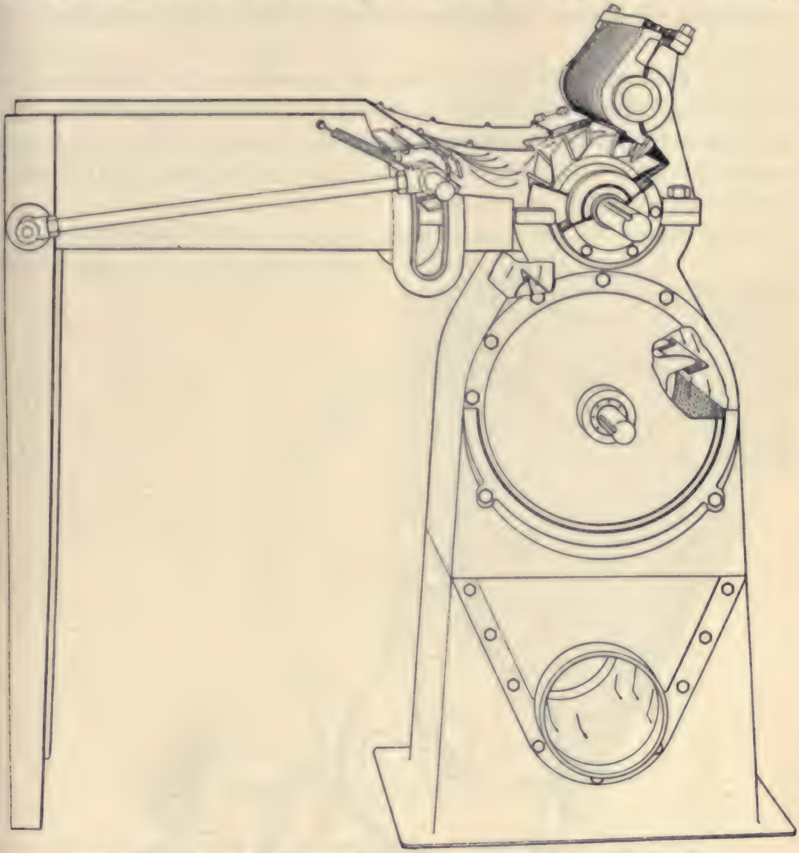

FIG. 18.— An alfalfa grinder which pulverizes the alfalfa by cutting.

Packers are used for packing the meal into sacks. There are several makes on the market, all employing the same general principle. The meal is carried into the sack through a tube and is packed by means of a slowly revolving auger (fig. 22).

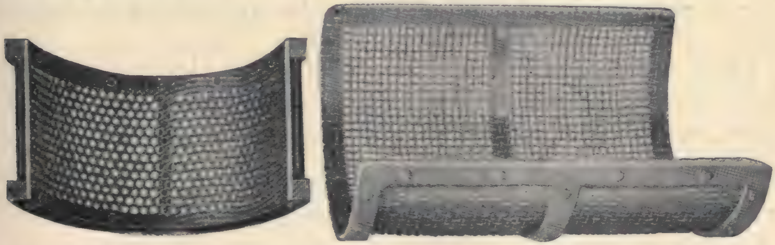

FIG. 19.—Parts of a screen-covered drum which determines the fineness of alfalfa meal.

The conveyors are of the usual type of construction. Each well-equipped grinding plant has two sets—one for conveying the hay to the grinder and the other for conveying the sacked meal from the packers.

Most of the commercial mills which depend on the local supply of hay have several wagons and hayracks for hauling the alfalfa from the field to the mill, the number ranging from about 20 for a mill with a capacity of 4 tons per hour to double that number for the larger plants.

Other equipment consists of wagon scales for weighing the hay as it comes into the mill and small scales for weighing the bagged meal.

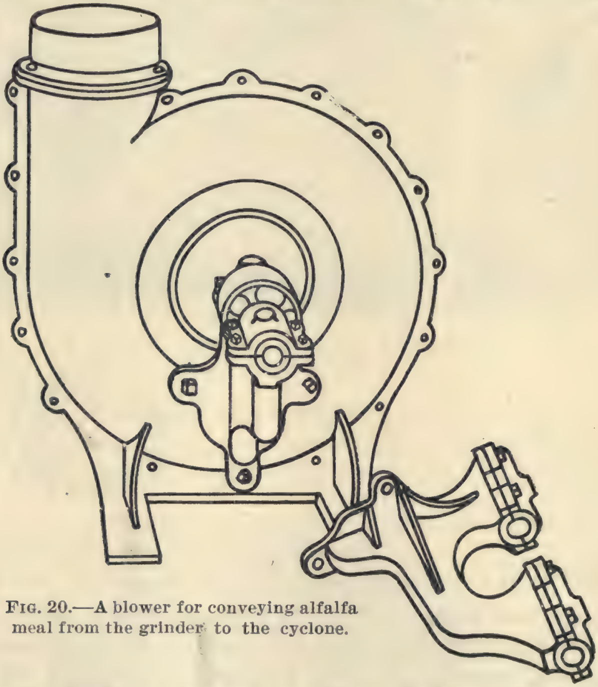

FIG. 20.—A blower for conveying alfalfa meal from the grinder to the cyclone.

Automatic feeders are used in plants that put out mixed feeds. They are so constructed that the grain and alfalfa meal are weighed automatically as they pass from the storage bins to the mixing vat. The feeders can be adjusted to deliver the various grains and meal in almost any proportion desired (fig. 23).

Large quantities of molasses are used in the alfalfa-mixed feeds, and a storage capacity of several hundred gallons is required. The tanks used for this purpose are usually of galvanized sheet iron and are placed under or outside the building. From these tanks the sirup is pumped to a smaller vat filled with a steam-pipe coil for heating it to such a temperature that it will mix readily with the alfalfa meal and other materials.

The mixer is a long galvanized sheet-iron vat through which runs a shaft fitted with paddles that are usually arranged auger fashion. The shaft revolves slowly and thoroughly mixes the various materials as they pass through (fig. 24).

In the past, various types of artificial driers for use in connection with alfalfa-meal mills have been placed on the market. Some of these were built to handle the green hay and others to handle the green material only after it had been cut or ground. The arguments that have been advanced by manufacturers in favor of the driers are that they enable the millers to put up an alfalfa meal of better color, better aroma, and a higher feeding value. The objections to the driers are their limited capacity and the excessive expense of operation, for which the market seems unwilling to pay. That artificial driers have not proved economical up to the present time is attested by the fact that practically none of them are in use to-day.

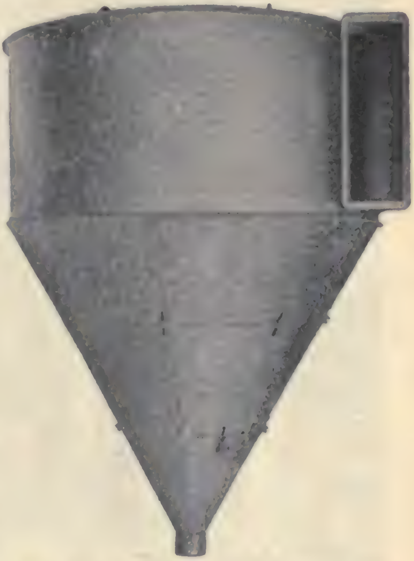
FIG. 21.—A common type of cyclone dust collector.

MAKING ALFALFA MEAL.

The first step in the manufacture of alfalfa meal is getting the hay to the mill. Some of the larger firms have complete outfits for hauling the hay, but in most cases it is delivered to the mills by farmers on their own racks or on racks furnished by the mills. Practically all the commercial firms own or hire a few teams, however, to insure a constant supply of hay when the farmers are otherwise engaged. In the early part of the season most of the hauling is from the field, but later it is from stacks. The basic price is for hay delivered at the mill, a deduction being made to cover the cost of the hauling.

When the hay reaches the mill it is either left on the wagons (fig. 25) until needed or is thrown into the storage shed. In parts of California where there is little danger of rain during the grinding season the hay is thrown in great piles outside the mills (fig. 26). From the wagons, storage shed, or piles the hay is thrown on the conveyor and carried to the grinder. The percentage of moisture in the hay when it goes to the grinder is, of course, quite variable, depending upon weather conditions and the length of time since harvesting. Ordinarily the moisture should not exceed 12 per cent, and under favorable conditions it may fall considerably lower.

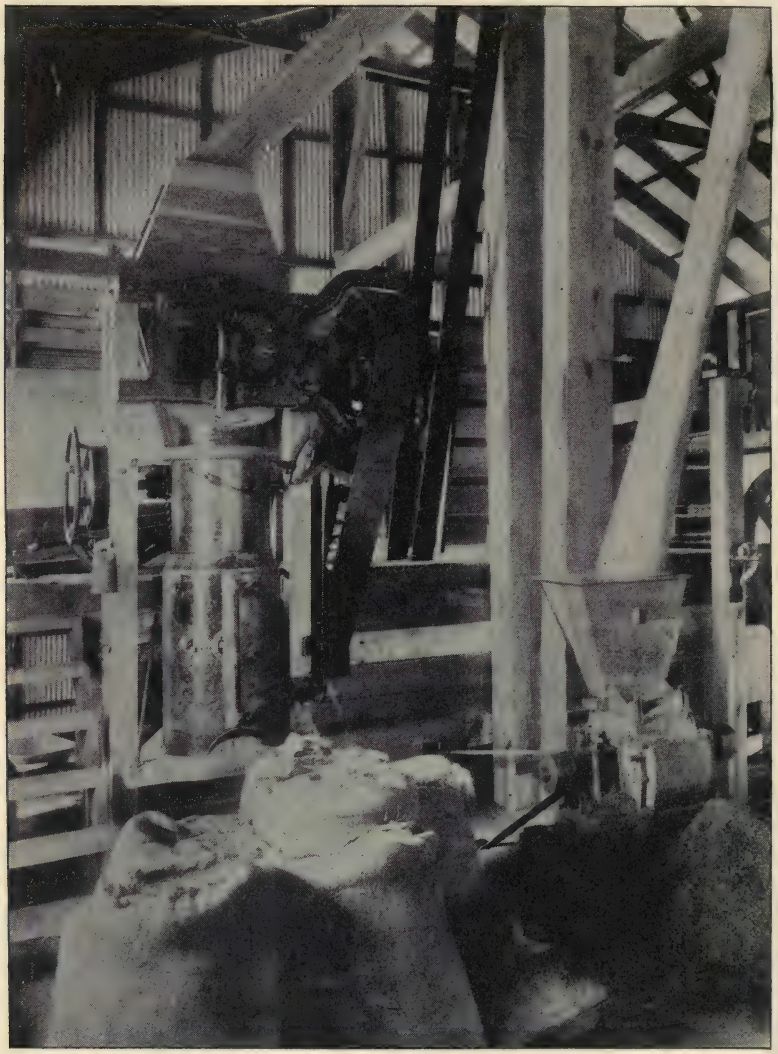

Fig. 22.—A common type of packer or bag filler, as used in an alfalfa meal mill.

The meal is taken from the grinder by suction produced by a fan and forced through a long galvanized tube to the cyclones. From the cyclones it goes to the packers, where it is put up in 100-pound bags. After weighing, the bagged meal is loaded directly on the car or is thrown on a conveyor which carries it to the warehouse, where it remains until marketed. If the warehouse is dry and the hay thoroughly cured before grinding, there is little danger of spoilage, although losses occasionally occur when the material is shipped to damp climates.

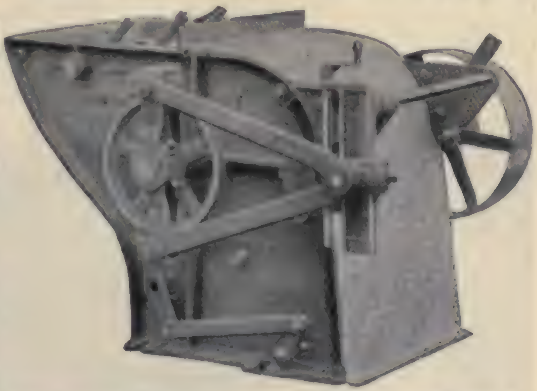

FIG. 23.—An automatic feeder used in plants putting out alfalfa mixed feeds.

The labor required for the different operations varies, but ordinarily a mill with a capacity of 4 to 5 tons of hay an hour will require 10 to 12 men.

The average grinding plant operates about eight months, or during what is commonly spoken of as the alfalfa season. Operations start in July, August, or September, depending somewhat upon the season and the quantity of hay available, and continue until March, April, or May, when ordinarily the supply of hay is exhausted. Mills located at the big terminals, such as Kansas City and Omaha, which depend on baled hay for grinding, operate as a rule throughout the year.

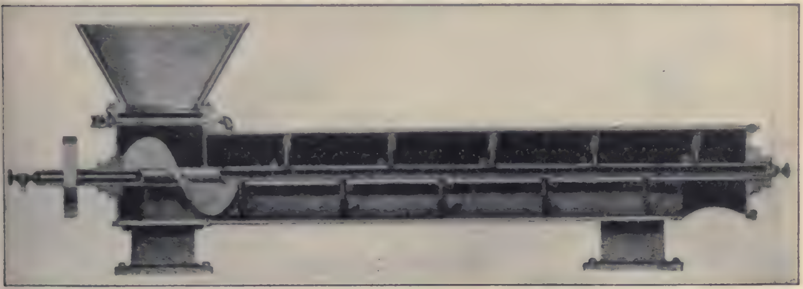

FIG. 24.—An alfalfa feed mixer.

The market recognizes about the same grades of meal as of hay; in fact, the grade of meal is determined largely by the grade of hay from which it is made. Aroma and color are two important factors in classifying meal, but unfortunately they do not always give a true index of its feeding value. For instance, there is considerable difference in the feeding value of meal made from hay that has browned in the stack and that made from hay that has browned by being exposed to unfavorable weather conditions, and yet if both have a good aroma they are sold on the market under the same grade. In addition to the grades that are determined by aroma and color, there are other grades that are determined by the fineness of the material. The finer grades cost more to manufacture and bring a somewhat higher price. The finely ground meal is intended for special purposes, such as poultry and hog feed, and ordinarily only the best hay is used in making it (figs. 27 and 28). Alfalfa straw is ground into meal to a limited extent, but it is apparent that such meal is not as good a feed as meal made from good alfalfa hay.

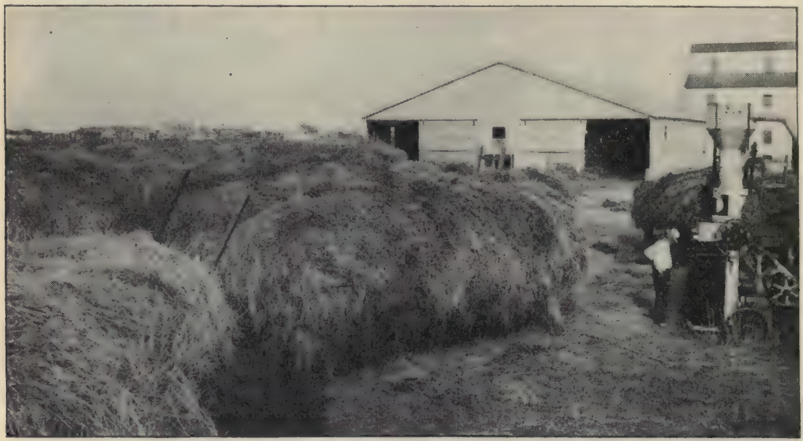

FIG. 25.—Hay wagons loaded with alfalfa waiting to be ground.

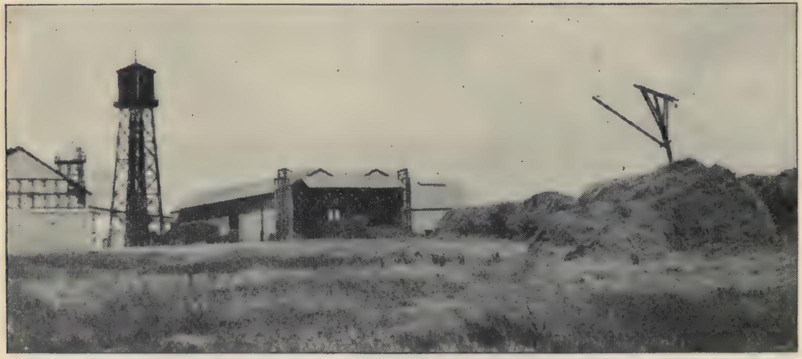

FIG. 26.—Alfalfa in piles outside the meal mill.

PORTABLE MILLS.

In the beginning of the alfalfa-meal industry most of the mills were of the portable type (fig. 29), but they have for the most part been discarded or converted into stationary mills. However, there is still an occasional demand for portable mills from the drier parts of the extreme West, particularly from California, where they seem to be operating with some success.

The general failure of the portable mill is attributed to its limited capacity, the inability of tractor engines to furnish sufficient power, and the necessity for ceasing operations whenever a wind or rain storm occurs, all of which tends greatly to increase the cost of grinding.

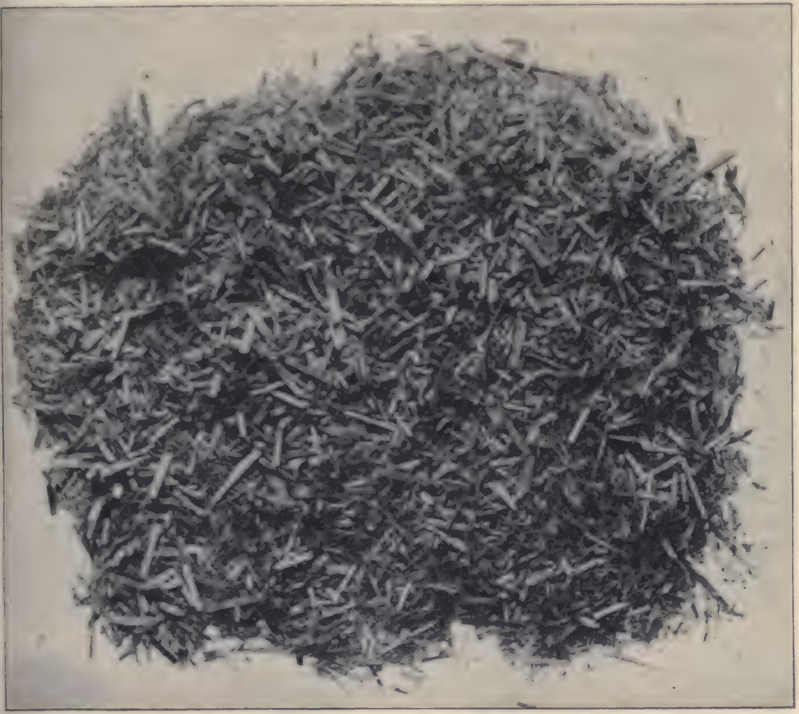

FIG. 27.—Alfalfa meal of the usual degree of fineness.

INDIVIDUAL MILLS.

Several big sheepmen and cattle feeders of Colorado have installed small plants for grinding hay and mixing the meal with molasses for home use. The cattle or sheep are taken from the ranges in the fall and fed alfalfa meal and grain until ready for the market. The cost of grinding is reduced to a minimum by being done when work is slack, and it is quite possible that the reduced wastage in feeding will pay this expense, but the extravagant profits claimed by some of these feeders are not substantiated by actual feeding tests.

FACTORS TO BE CONSIDERED IN CONNECTION WITH THE BUILDING OF A GRINDING PLANT.

There are several important factors that should be carefully considered by a prospective entrant into the alfalfa-meal industry, such as the cost of the plant, the availability of hay, shipping facilities and market for the meal, the availability of labor, and the climatic conditions.

The cost of the plant is, of course, subject to wide variations, depending upon the capacity and the character of the buildings and machinery. In the long run substantial buildings that are as nearly fireproof as practicable and durable machinery will be found the most economical. To build a satisfactory commercial mill under normal conditions there should be available a capital of $15,000 to $40,000.

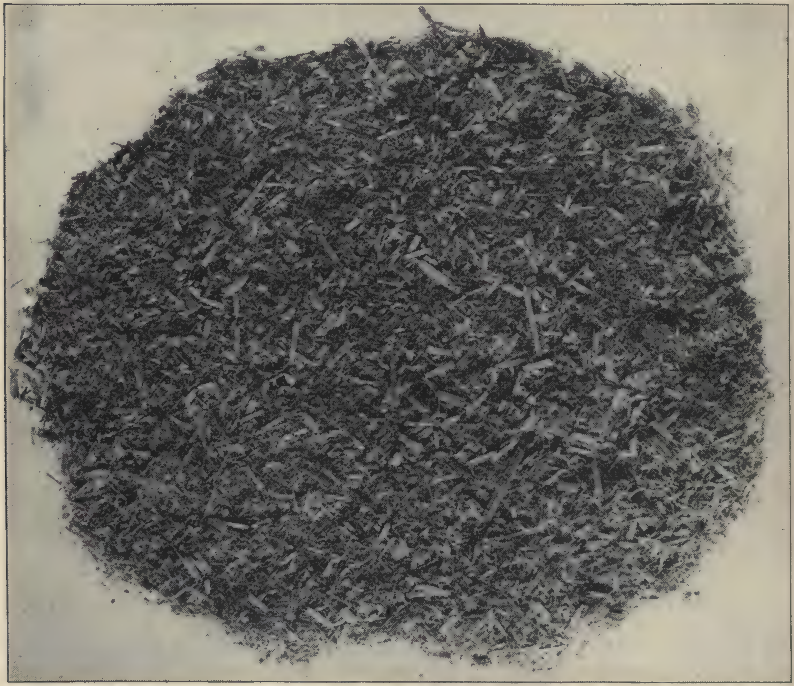

FIG. 28.—Finely ground alfalfa meal.

One of the important factors in the success of the alfalfa-meal industry is a readily available supply of good hay at a relatively low price. For this reason most of the successful mills that manufacture only straight meal are located in the big alfalfa districts and depend upon being able to procure hay within easy hauling distance, which ordinarily does not exceed 5 miles. The quantity of hay required depends upon the capacity of the mill. Ordinarily a 2-ton mill will require 4,000 to 5,000 tons for the operating season. Where the local supply is not sufficient, baled hay may be shipped in and ground, then forwarded to destination, the miller paying a through rate from the point of origin to the point where the sale is made. This increases somewhat the cost of producing meal. It is almost essential that the mill be located on a railroad, for convenience in shipping and to eliminate charges for hauling.

Careful consideration should be given to the probable market for the product and also to the comparative prices of hay and meal to determine so far as possible whether the difference will leave a profit after deducting the cost of manufacturing and shipping.

The possibility of obtaining sufficient labor at a wage that will still leave a profit for the manufacturer should be definitely determined. In considering this item one should not lose sight of the fact that mills are not infrequently compelled to shut down for repairs and adjustments. This, of course, adds to the cost of the manufacture of the meal, since the men are paid just the same as when the mill is operating. Other factors that should be considered in this connection are the salaries of salesmen and officers of the company, if any, and other items of overhead expense.

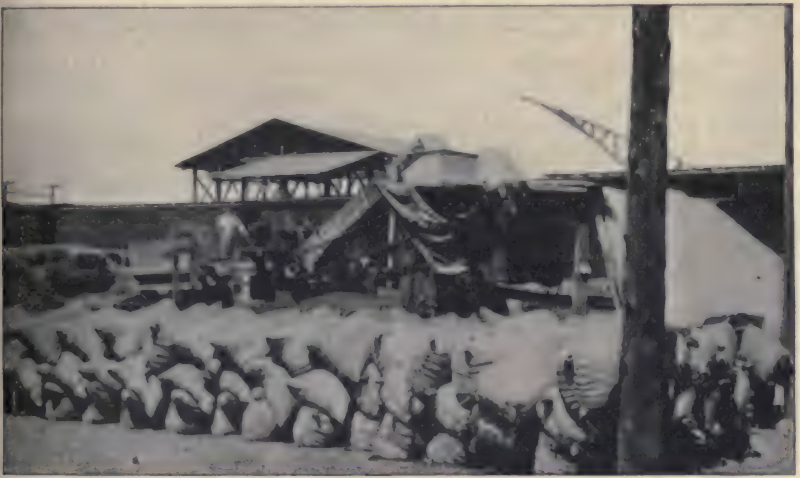

FIG. 29.—A portable alfalfa meal mill.

The relation of climate to the making of alfalfa meal is a factor of great importance. Unfavorable weather increases the cost of manufacture by reducing the capacity of the mill and increasing the proportion of spoiled hay. For these reasons the drier sections of the country are best suited to the industry, and it is there that most of the big commercial plants are located.

There are numerous other items of cost that enter into the manufacture of alfalfa meal. Some of them, such as power charges, cost of sacks, and interest on the investment, can be calculated with a considerable degree of accuracy, but other items, such as repairs, losses of various kinds incident to the purchase and storage of hay and to the manufacture, storage, and sale of the meal, can only be determined after a season's run.

FEEDING ALFALFA MEAL.

Various experiments have been made with alfalfa meal to determine its value for different kinds of live stock. These experiments have been conducted along two lines, one to determine the economy of feeding alfalfa meal as compared with alfalfa hay and the other to determine its value in replacing high-priced concentrates, particularly wheat bran.

In experiments comparing the value of alfalfa meal and wheat bran the State Agricultural Experiment Stations of Vermont, Massachusetts, and Pennsylvania have reached the same general conclusion—that alfalfa meal is slightly inferior to wheat bran for milk production. The results at the Nebraska Agricultural Experiment Station, on the other hand, indicated that the meal is fully equal to wheat bran. The former gave a slightly lower production of milk and butter fat, but this was overcome by the gain in weight.

In feeding swine the Wyoming Agricultural Experiment Station found that alfalfa meal gave decidedly poorer results than middlings when fed with a corn ration, while the Colorado station concluded that although shorts and corn gave more rapid gains than alfalfa meal and corn the latter was so much more economical that a farmer could afford to feed somewhat longer. In comparing alfalfa meal with alfalfa hay in a ration for fattening hogs the Nebraska Agricultural Experiment Station concluded as the result of experiments covering five years that alfalfa was fed more satisfactorily without cutting or grinding. The gains were more rapid and cheaper where the hay was fed from the racks. The Colorado and Kansas stations also found that in feeding hogs the grinding of alfalfa hay into meal did not increase its value sufficiently to pay for the extra expense. The New Jersey Agricultural Experiment Station found that alfalfa meal as compared with alfalfa hay in a ration for brood sows considerably reduced the cost of maintenance.

During the winter months, when no green succulent feed is available, poultry apparently utilize a small mixture of alfalfa meal in their daily mash to good advantage, but this does not take the place of succulent green feed.

The mere grinding of alfalfa hay does not materially alter its composition, and that it has little effect on its feeding value is indicated by the results cited above. The advantages of the meal are that it is fed with less waste than hay and is in a convenient form, especially for use in towns and cities. There is also a considerable reduction on freight charges when shipped for long distances.

ALFALFA-MIXED FEEDS.

The mixed-feed industry has made wonderful strides during the past few years, and attempts have been made to utilize everything that has any possibility as a feed, including the by-products from the flour and feed mills and elevators. In the search for constituents for these various mixtures alfalfa meal has come to occupy an important place, partly owing to the fact that it is high in protein and can be used to advantage to balance the feed and partly because it is cheaper than most other protein feeds. The firms putting out mixed feeds containing alfalfa meal are very numerous, and nearly all of them put out several such feeds, the number in one instance running as high as 37.

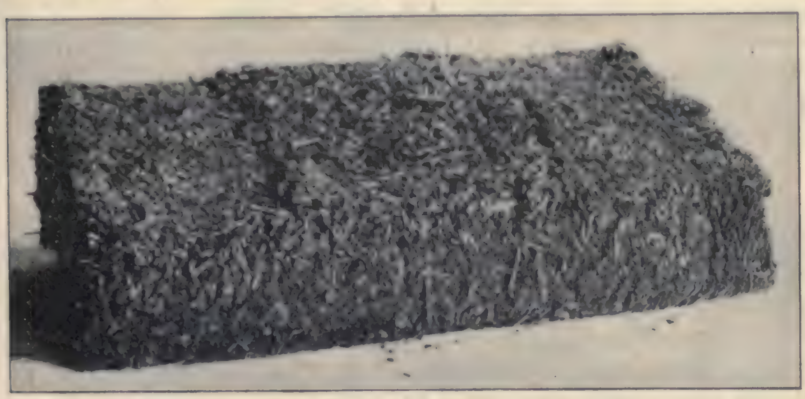

FIG. 30.—Alfalfa mixed feed put up in pressed cakes 6 by 12 by 2 inches.

The simplest mixture, and one that is quite extensively used for both horses and cattle, consists of alfalfa meal and molasses, the proportion of molasses ranging all the way from 15 to 40 per cent. The original purpose of the molasses was to prevent the loss of the fine material through the sack and to keep down the dust, which is objectionable in feeding horses and sheep. Both cane and beet sirup are used for mixing with alfalfa meal. The cane sirup is sweeter and seems to be more palatable, but the beet sirup carries a higher percentage of mineral matter, which some feeders consider an advantage, especially for the cattle. The cane sirup has a tendency to darken the product more than beet sirup, so that it does not present quite as good an appearance on the market.

The concentrates used in the alfalfa-meal mixtures are about the same as those found in other mixed feeds destined for the same purpose, such as corn, oats, barley, and molasses for horses and fattening cattle, and wheat bran, cottonseed meal, corn, and barley for dairy cows. Ordinarily only the very finely ground alfalfa meal goes into the hog and chicken feeds, which contain, in addition, the usual ingredients, such as corn, oil meal, wheat, meat meal, and middlings.

Recently attempts have been made to place alfalfa-mixed feeds on the market in the form of pressed cakes of various dimensions (fig. 30), the advantages claimed being greater convenience in handling and reduced shipping charges.

Unfortunately, the chemical analyses of these mixed feeds are not a fair criterion of their feeding value, and therefore much depends upon the honesty of the manufacturer and his desire to establish a reputable business by giving his customers true value for their money. Reliable firms use only high-grade materials, their policy being to use only ingredients that in themselves are palatable feeds, while other firms depend largely on the poorer quality of grain, alfalfa meal, and by-products from mills and elevators. Because of the uncertainty as to the actual feeding value of the various alfalfa-mixed feeds, it will usually prove more satisfactory and less expensive for feeders to buy the ingredients and do their own mixing.

FAKE AND FAD ALFALFA PRODUCTS.

The general recognition of the high value of alfalfa as a forage crop and the extensive advertising that has been conducted in its behalf have produced attempts to extend its use to the making of human food, medicines, textiles, dyes, and other commercial products. These attempts have, for the most part, been made either with fraudulent intent or with unwise enthusiasm. Included in the list are alfalfa flour, confections, table sirups, soda-fountain sirups, flavoring extracts, tea and coffee substitutes, medicines, and fabrics. Alfalfa flour for the making of bread, cakes, and muffins does not compare at all favorably with the cereal flours or meals, and at best it must have large proportions of other flours mixed with it before it can be used in baking. As a constituent of confections and for the making of table and soda-fountain sirups, flavoring extracts, and tea and coffee substitutes alfalfa has nothing to commend it. So far as is known it possesses no special medicinal properties, and its fiber is not commercially usable. Frequently rumors have become current that alfalfa seed is used in the making of dyes, but careful investigations have so far failed to disclose any foundation for such statements. The only legitimate use for alfalfa seed so far as is known is for seeding purposes. The readers of this bulletin are urged not to waste their money on alfalfa products like those mentioned in this paragraph.

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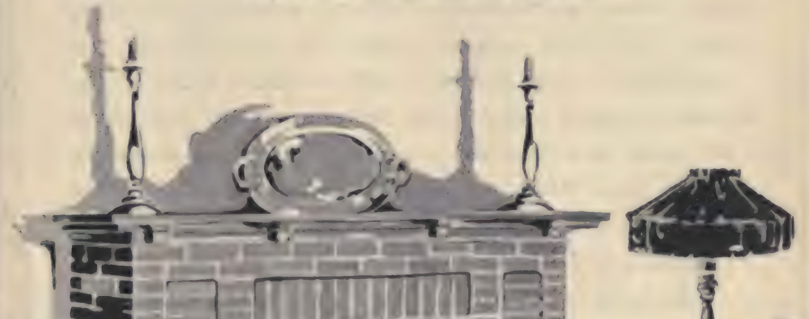
FARMERS' BULLETIN 1230
UNITED STATES DEPARTMENT OF AGRICULTURE

CHIMNEYS & FIREPLACES

They Contribute to the Health
Comfort and Happiness of the Farm Family

HOW TO BUILD THEM



OF THE mistakes commonly made in home building none is more frequent than faulty design and construction of chimneys and fireplaces. Though the use of the fireplace is one of the oldest methods of house heating there are few who understand the principles of its action, and even experienced masons frequently fall into errors in building which seriously detract from the efficiency of the installation. No defect in the construction of the house detracts more from the comfort of the home and none is a greater menace to life and property than a poor chimney and fireplace. Bad chimney design is also the cause of much avoidable expense in heating the house.

This bulletin is designed to give the householder and prospective builder, and especially the farmer or other rural resident who builds or superintends the building of his own home, a working knowledge of the principles to be observed in planning and building these important parts of the house, which, if they are observed, will go a long way to promote the comfort of the home and insure the safety of the property.

Contribution from the Bureau of Public Roads
THOS. H. MacDONALD, Chief

Washington, D. C.   Issued December, 1921; reprint, April, 1922

CHIMNEYS AND FIREPLACES.

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FUNCTION OF CHIMNEYS.

THE prime function of a chimney is to produce a draft that will cause sufficient combustion and carry off the resulting smoke; incidentally it assists ventilation. Many unsatisfactory heating plants and much excessive fuel consumption are due to improperly constructed chimneys, which are the rule rather than the exception. Although many of these are more inefficient than dangerous, yet reports of the National Board of Fire Underwriters[1] show that a larger number of fires are caused by defective chimney construction than by anything else. The annual loss resulting from such fires is greater than the fire loss from any other cause. Poor chimney construction is responsible for smoke pollution of the air, waste of fuel, and poor heating.

The most common faults in chimney construction are:

1. The use of unsuitable materials. Clay sewer pipe, hollow building blocks, or unprotected concrete should not be used.

2. Improper laying of brick. Brick should not be laid on edge and should be properly bonded. Lining should be used in all brick chimneys the walls of which are less than 8 inches thick. Lack of mortar, especially in the perpendicular joints, ruins many an otherwise good chimney.

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[1] "Dwelling Houses," a publication issued by the National Board of Fire Underwriters in the interest of fire protection, has been used as a basis for the matter relating to the requirements and construction of chimneys and methods of fire protection.

3. Failure to support the chimney properly. It should never be carried on any timber construction of the building, and when it rests upon the ground sufficient masonry foundation should be provided to prevent settling.

4. Building inflammable material into the chimney or against it without proper insulation.

5. Failure to anchor the smoke pipe properly to the chimney.

6. Neglect of the connection between smoke pipe and flue or of the flue itself. The connection should be tight; rusted pipe should be replaced; the chimney should be kept clean and the joints in the brickwork properly pointed.

7. Lack of a tight flue. A flue free from leakage is unusual. Every flue should be tight enough to prevent escape of smoke when tested as described on page 14. A leaky flue is the most frequent cause of heating troubles, high fuel bills, and destructive fires.

8. Failure to maintain the full sectional area at the bend when a flue is offset.

9. Use of the main heating apparatus flue for water heater or other auxiliary equipment. The furnace or heater should have a separate flue.

10. Failure to provide a separate tight cleanout for each flue. Two or more otherwise good flues may be rendered inefficient if led into one cleanout, since air may be drawn from one into another and the draft in all affected.

11. Presence of deep pockets leading to cleanouts. They may cause eddying currents that are detrimental. Pockets should be only deep enough to permit installing a cast-iron cleanout frame and door just below the smoke-pipe entrance. Deep pockets allow soot accumulation that may take fire.

THE CHIMNEY DRAFT.

The draft depends entirely upon the chimney flue. The better the flue the more satisfactory and efficient will be the operation of the entire heating apparatus. The strength or intensity of the draft is dependent mainly upon the tightness, size, and height of the chimney flue. The most common error in chimney construction is failure to distinguish between the size of flue necessary for free passage of the volume of smoke from a given amount of fuel and that which with proper height will produce the required draft. A chimney may be high enough, yet have an area too small to carry properly the volume of smoke. On the other hand, the size may be sufficient but the chimney too low to produce a draft strong enough to pull the air through the fire at a sufficiently rapid rate. Either fault or a combination of the two will result in unsatisfactory service.

Draft in a chimney flue is caused by the difference in weight between a volume of air on the outside and an equal volume of products of combustion from the fire on the inside. The higher the temperature of a given weight of air, the greater is its total volume and the lighter the weight of its unit volume. This produces a condition of unbalanced pressures at the base of the flue. The rising of the lighter gases within the chimney tends to equalize the pressures. So long as the fire burns this condition of unbalanced pressure presists, the result being draft.

This is the basic principle which governs chimney action and upon which the draft depends. The greater the difference between the temperature in the flue and that outside the greater the tendency toward equalization of pressure and hence the better the draft. In summer the draft of a chimney is not as good as in winter because the difference in temperature between the outside air and that of the gases in the flue is less.

SHAPES AND SIZES OF FLUES.

The most efficient chimney is one built perfectly straight with a round or nearly round flue and a smooth interior surface. There is no advantage in reducing the sectional area toward the top. The cross section and height are determining factors. The transverse area must be sufficient to pass the volume of air required to burn the fuel properly, and the height must be great enough to insure against interference with the draft by adjoining buildings or projections of the same building and to produce a sufficiently strong draft.

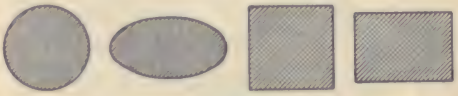


FIG. 1.—Round flues offer the least resistance to the passage of gases, but most residence flues are made either square or oblong for structural reasons.

Loss in draft strength is due to air leakage, and friction of the gases against the sides of the chimney. A round flue (see fig. 1) is the most desirable because it offers less resistance to the spirally ascending column of smoke and gases. The elliptical is second choice so far as the movement of the gases is concerned, but the difficulties that it presents in manufacture and construction eliminate this shape. A rectangular chimney either square or oblong is not effective over its full transverse area; for the rising column, being approximately circular in section, does not fill the corners. However, square or oblong forms are far more common than the round; owing to the greater cost of round flue construction. Square flues are preferable to oblong so far as efficiency is concerned, but in the larger sizes of house flues the oblong shape is more generally used because it fits to better advantage into the plan of the house. An oblong flue should never have the long side more than 4 inches greater than the short side. A flue 8 inches by 16 inches is bad flue construction for draft purposes. The sizes given in Table 1 are recommended by the National Warm Air Heating and Ventilating Association. Like all data for both high and low pressure flues, these sizes are based on experience, not on scientific data, and are subject to modification by further research. The dimensions given are for unlined flues. The actual inside dimensions of flue tile are slightly different because of the lack of standardization. In selecting the flue for a furnace or other large heating unit an 8-inch by 12-inch size should be considered the minimum for a lined or unlined flue, and 12 inches by 12 inches the minimum for a lined or unlined flue whose height is more than 35 feet measured above the grate level. If the chimney is designed for a small unit such as a laundry stove or kitchen range an 8-inch by 8-inch flue may be used.

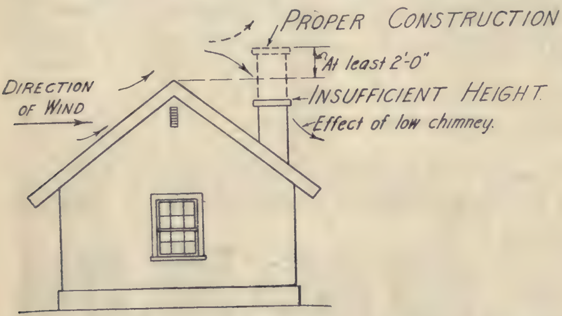


FIG. 2.—Top of chimney should be at least 2 feet above the top of ridge in order that the wind currents may not be deflected down the chimney.

The proper size of flue depends upon the size of the heater or furnace for which it is to be used. All manufacturers' catalogues contain the size of the smoke pipe for each particular heater, and from Table 1 (minimum) dimensions for round, square, and oblong flues may be selected; or if the catalogue contains stack sizes select the proper one. The flue tile to be used should have a transverse net inside area approximately equal to that of the smoke pipe.

TABLE 1.

Diameter of smoke pipe or round chimney flue.	Size of chimney flue.	Height of chimney flue above grate.	Diameter of smoke pipe or round chimney flue.	Size of chimney flue.	Height of chimney flue above grate.
Inches.	*Inches.*	*Feet.*	*Inches.*	*Inches.*	*Feet.*
8	8 by 12	35	15	16 by 16	45
9	8 by 12	35	16	16 by 18	45
10	12 by 12	35	17	16 by 20	50
11	12 by 12	40	18	16 by 20	55
12	12 by 12	40	19	20 by 20	55
13	12 by 16	40	20	20 by 24	60
14	12 by 16	45			

HEIGHT OF CHIMNEY.

In Table 1 the minimum height of the chimney above the grate is given as 35 feet. Higher chimneys are considered more satisfactory, and authorities claim that any flue under 40 feet in height will produce an erratic draft, good on some days but poor on others. The force or direction of the wind may be the cause, or the amount of moisture in the air, or the quality of the fuel may be responsible. The higher the chimney the less will be the possibility of counter air currents and the stronger and more constant the draft. Soft coal and the sizes of hard coal known as pea and buckwheat are apt to cake and fill up the air spaces through the bed of the fire, with the result that an intense draft is required to give the fuel sufficient air.

The top of the chimney should extend at least 3 feet above flat roofs and 2 feet above the ridge of peak roofs (see figs. 2 and 3), and it should not be on the side of the house adjacent to a large tree or a structure higher than itself (see fig. 4), for these may cause eddies and force air down the chimney. A poor draft will most likely result when the wind is blowing in the direction indicated.

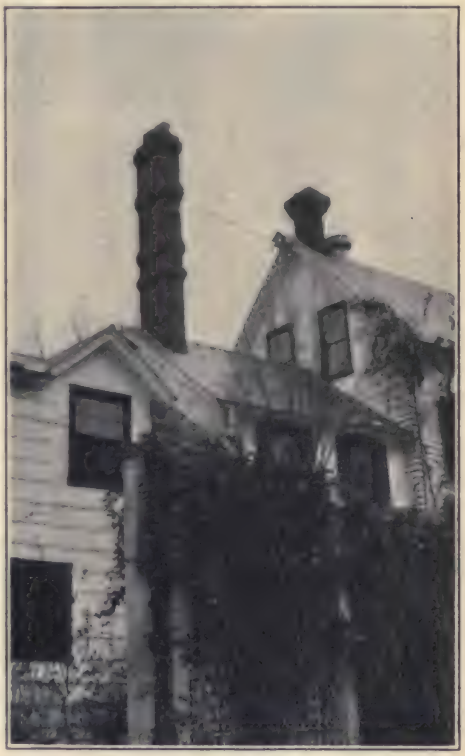


FIG. 3.—Extensions to the chimney required in order that it might draw properly.

FLUE LININGS.

Although chimneys are built unlined to save expense, those properly lined with tile are undoubtedly more efficient. Linings prevent disintegration of mortar and bricks through the action of flue gases. This disintegration and that occurring from changes in temperature result frequently in open cracks in the flue (see fig. 5–B) which reduce or check the draft. If loose brick and mortar should fall within they may lodge so as to cause partial or almost complete stoppage (see fig. 5–D). The danger of this latter condition is greater if the flue be built with offsets or bends. Any change in direction should be made as gradual as possible and with an angle not greater than 30 degrees with the perpendicular.

The most important requirement for a flue lining is that it withstand high temperatures and not be subject to disintegration by ordinary flue gases. It should be made of fire clay and for the purpose. The thickness should be 1 inch. It should be set in cement mortar with the joints struck smooth on the inside. Each length of flue lining should be placed in position, and the brick should then be laid around it; if the lining is slipped down after several courses of brick have been laid, the joints can not properly be filled with mortar and leakage is almost sure to result.

Well-burned clay flue linings are generally satisfactory for dwelling-house chimneys used for stoves, ranges, fireplaces, and furnaces. In regions where the fuel is natural gas, hot flue gases are said to have caused linings to disintegrate and crumble off. In such a case it may be necessary to use a fire clay that has stood the test or line the chimney with fire brick.

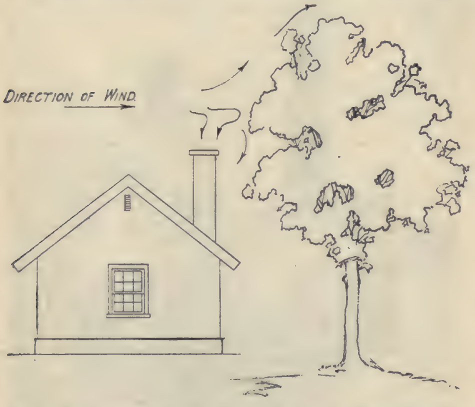


FIG. 4.—Large trees located near chimney tops may deflect wind currents down the chimney. This may be avoided by placing the chimney on the opposite side of the building.

Linings are manufactured in round, square, and oblong shapes, but not in elliptical. The oblong and square shapes are better adapted to brick construction than the round. They permit of simpler and less expensive masonry work. On the other hand, the round shape produces better draft and is easier to clean.

A fireplace flue, if straight, should be lined from the throat continuously to the top. The smoke chamber should be lined with fire clay or cement mortar one-half inch thick. In case the masonry in front of the throat is less than 8 inches thick the lining should start at the bottom of the lintel. The hottest part of the flue is at its throat, and if it is not lined at that point or if the masonry is not of sufficient thickness, there is danger of overheating. Careful attention should be given to details of flue construction in order to assure satisfactory operation and reduce the fire hazard.

LOCATION AND WALL THICKNESS.

The best location for the chimney is near the center of the building, for when so located its four walls are kept warm; cold winds can not chill it and cause it to draw poorly. However, it is not always possible to plan the arrangement of rooms so that the chimney may be thus located. The outside wall of a chimney should be at least 8 inches thick in order to reduce heat loss and the chance of air leakage into the flue.

If the flue is lined and the chimney is not higher than 30 feet, its walls, if of brick, may be made 4 inches thick, provided adjacent inflammable material is properly insulated. If unlined, the walls should not be less than 8 inches thick. It is not good practice to place the linings of two flues side by side. If there is more than one flue in a chimney, the flues should be separated from each other by a division wall of brick at least 4 inches thick (see fig. 6), bonded into the side walls, and the joints of the flue linings should be staggered or offset at least 6 inches (see fig. 7). This construction insures stability, reduces the chance for air leakage between flues, and prevents the possibility of a fire in one flue involving an adjacent flue. If stone is used in chimney construction, the walls should be at least 4 inches thicker than brick walls.

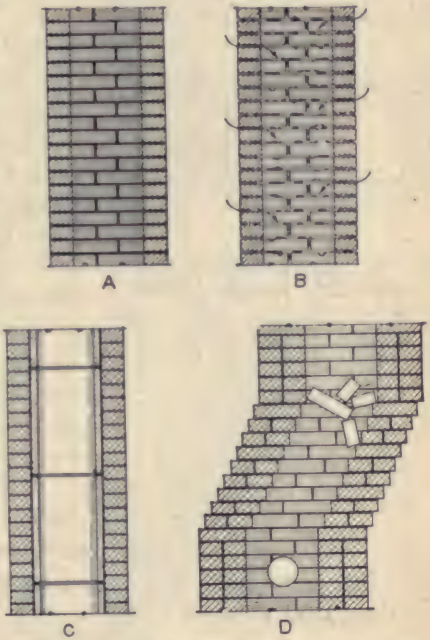


FIG. 5.—A. An unlined chimney before use. B. Same chimney, after being in service. Frequently the heat and weather cause the mortar to disintegrate so that air leaks in through the joints, causing a reduction in the draft. C. Same chimney as A, showing terra cotta flue lining in place. D. An unlined chimney with offset. Loose brick and mortar may fall and become lodged at the offset during construction or loosening of the points and disintegration may cause bricks from an uncapped chimney to check the draft completely.

Walls of concrete chimneys should be not less than 4 inches thick and they should always be reinforced in both directions; otherwise cracking during the setting of the concrete or, later, due to temperature changes or unequal settlement of the foundation is apt to occur. Concrete blocks are not recommended, but if they are used each block should be reinforced with steel running continuously around it and the blocks should be not less than 4 inches thick. They should be lined with the best flue lining. All monolithic concrete chimneys with walls less than 8 inches thick should be lined.

OPENINGS INTO THE CHIMNEY.

It is not unusual to find an opening into a chimney other than for the smoke pipe of the main heating apparatus. This is a frequent cause of unsatisfactory operation. No range, stove, fireplace, or ventilating register should be connected with the chimney flue built for the heating apparatus. If it should be desired to use an existing abandoned fireplace chimney for a range or stove the fireplace flue should be closed tight about a foot below the place where the smoke pipe enters.

There should be but one connection with a flue, if for no other reason than to decrease the fire hazard. Fires frequently occur from sparks that pass into the flue through one opening and out through another. Two stoves, one on the first floor and one on the second, may be connected with the same chimney flue, but if the fire in the upper stove is hotter than in the lower, the lower will have practically no draft.

A soot pocket provided with a door for cleaning it out is very convenient. The door should be placed just below the smope-pipe opening, and care must be taken to see that it fits snugly and is always closed so tight that no air can get in.

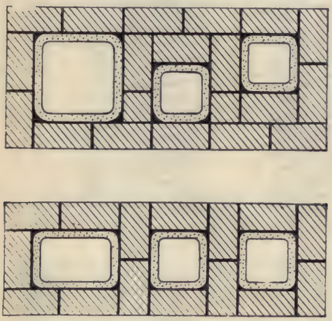


FIG. 6.—A division wall of at least 4 inches of brick should separate each flue from any others in the same chimney. Either of the arrangements shown will produce a good bond.

SUPPORTING THE CHIMNEY.

All chimneys should be built from the ground up. None of the weight should be carried by any part of the building except the foundation. Proper foundations should be provided at least 12 inches wider all round than the chimney. If the chimney is an exterior one, and there is no basement or cellar, its foundation should be started well below the frost line. Otherwise the base of the chimney should be at the same level as the bottom of the foundation of the building.

No chimney should rest upon or be carried by wooden floors, beams, or brackets, nor should it be hung from wooden rafters. Wood construction shrinks, and beams supporting heavy loads always deflect in time. Sagging of the beams injures the walls and ceilings of the house and is apt to crack the chimney and render it dangerous. Chimneys usually extend several feet above the roof, exposing considerable surface to the wind, and unless the support is stable they are likely to sway during a gale with the possibility of the joints at the roof-line opening. Openings in a flue at this point are especially dangerous, for sparks from the flue may come into contact with the woodwork of the roof. This swaying may also cause leaks in the roof.

The brickwork around all fireplaces and flues should be laid with cement mortar, as it is more resistant than lime mortar to the action of heat and flue gases. It is well to use cement mortar for the entire chimney construction. All mortar used for chimney construction, except for laying fire brick, should be proportioned as follows: Two bags of Portland cement, not less than 188 pounds, and one bag of dry hydrated lime, 50 pounds, thoroughly mixed dry, and to this mixture should be added three times its volume of clean sand with sufficient water to produce proper consistency. When dry hydrated lime is not available, 1 cubic foot of completely slaked lime putty may be substituted for the dry hydrate.

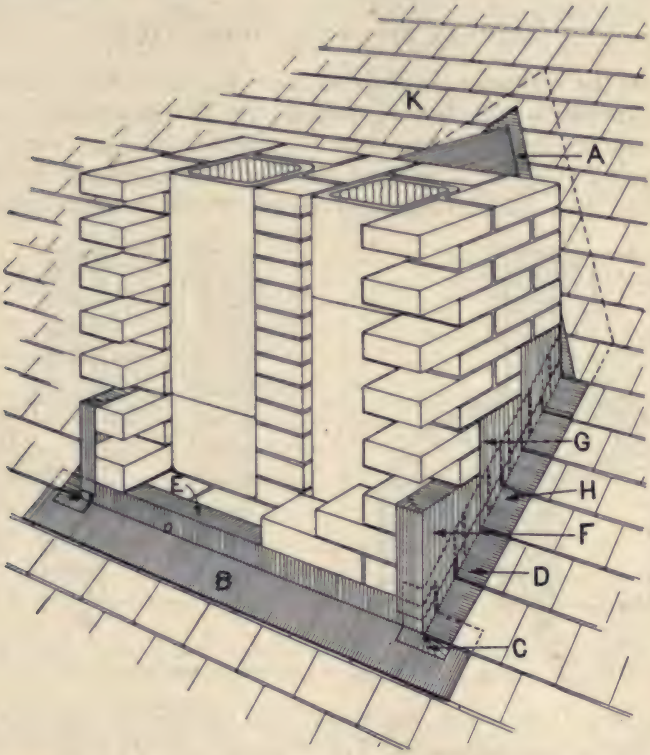


FIG. 7.—Chimney and roof connection. Sheet metal A should have shingles K over it at least 4 inches. Apron B bent as at E with base flashings C, D, and H and cap flashings F and G, lapping over the base flashings provide watertight construction. When the chimney contains two flues the joints should be separated as shown.

CAPPING THE CHIMNEY.

Brick chimneys should be capped with stone, concrete, or cast iron. Unless a chimney is capped the top courses of brick may become loosened and therefore dangerous. Plain topped chimneys will last longer and are safer than those of an ornamental character. The opening in the cap piece should be the full size of the flue.

CHIMNEY AND ROOF CONNECTION.

Where the chimney passes through the roof the construction should provide space for expansion due to temperature changes, settlement, or slight movement of the chimney during heavy winds. (See fig. 7.) Copper is the best material for flashings. It is easier to handle than galvanized sheet metal, which is more often used because of its lesser cost, but which will corrode in time, both from inside and outside exposure. Tin or black iron are cheaper but will rust quickly unless frequently painted. Lead and zinc are expensive and should not be used for chimney flashings, for in case of fire under the roof they will melt and leave an opening to create a draft by which the intensity of the fire will be increased.

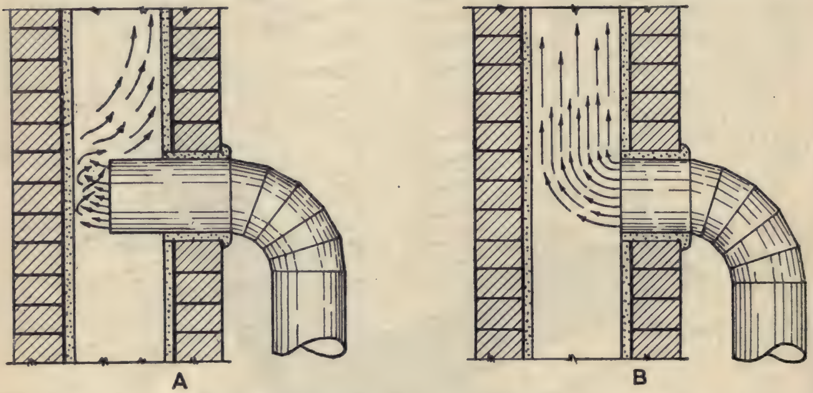


FIG. 8.—A. Wrong connection, producing interference and a poor draft. B. Correct construction, producing a good draft by providing a free passage for the gases.

CHIMNEY CONNECTIONS.

Proper care in setting and looking after smoke pipes connecting with chimneys would greatly lessen the number of fires chargeable to defective construction.

In fitting the smoke pipe no opening should be left around it, and the pipe should not project into the flue lining. (See fig. 8.) The joint should be made air-tight by a closely fitting collar and boiler putty or fireproof cement. The proper construction is shown in figure 8–B, but if the pipe extends into the flue a shelf is formed on which soot will accumulate, the flue area will be reduced and a poor draft may result.

Smoke pipes should enter the chimney horizontally, and the connection through the chimney wall to the flue should be made with fire clay or metal thimbles securely and tightly set in the masonry. If the walls are furred, no wood should be within 12 inches of thimbles or any part of the smoke pipe. The space between the thimble and wood furring should be covered with metal lath and plaster.

Flue holes when not in use should be closed with tight fitting metal covers. If the room is papered the metal covers may also be papered, provided there is no other smoke connection with the flue, or provided a protective coating of asbestos paper is first applied over the metal. If there is another connection the metal may become hot enough to scorch the unprotected wall paper or set it afire. No smoke pipe should be permitted within 18 inches of any woodwork unless at least that half of the pipe nearest the woodwork is protected properly by 1 inch or more of fireproof covering. A metal casing 2 inches from the upper half of the pipe is sometimes employed to protect woodwork directly above it. When a smoke pipe is so protected it should never be less than 9 inches from any woodwork or combustible material. The storage of wooden boxes, barrels, or any combustible should not be permitted under or near a furnace smoke pipe.

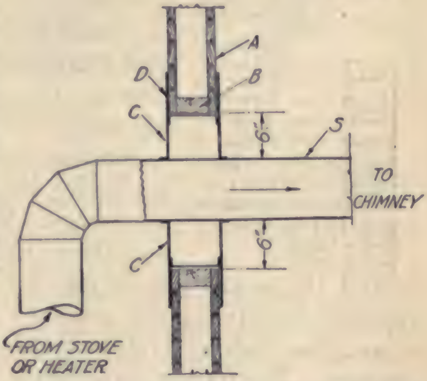


Fig. 9.—Smoke pipe passing through a partition. A, ⅞-inch sides of partition; B, 2 by 4 studs in partition; C, ventilating holes in the double galvanized iron ventilating thimble D. Thimble should be at least 12 inches larger than pipe S.

If a smoke pipe must be carried through a wood partition the woodwork should be properly protected. This can be done by cutting an opening in the partition and inserting a galvanized iron double-walled ventilating thimble at least 12 inches larger than the smoke pipe (see fig. 9), or protection may be afforded by at least 4 inches of brickwork or other incombustible material. Smoke pipes should not pass through floors, closets, or concealed spaces. They should not enter a chimney in a garret. They should be cleaned at least once a year.

CHIMNEY INSULATION.

All wooden construction adjacent to chimneys should be insulated. A space of 2 inches should be left between the outside face of a chimney and all wooden beams or joists. This space should be filled with some porous, nonmetallic, incombustible material. Loose cinders serve well. (See fig. 10.) Do not use brickwork, mortar, or solid concrete. The filling should be done before the floor is laid, as it not only forms a fire stop but prevents accumulation of shavings or other combustible material. Baseboards fastened to plaster which is directly in contact with the outside wall of a chimney should be protected by placing a layer of fireproof material at least one-eighth inch thick between the woodwork and the plaster. (See fig. 10.)

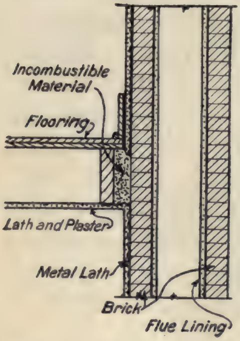


FIG. 10.—No woodwork should be permitted closer than 2 inches to the outside face of a chimney. Baseboards in front of chimneys should be protected with asbestos board.

Wooden studding, furring, or lathing should not under any circumstances be placed against a chimney. Wooden construction should be set back from the chimney as indicated in figures 11 and 12; or the plaster may be applied directly to the masonry or to metal lathing laid over the masonry. The former is the better method, as settlement of the chimney will not crack the plaster. It is recommended that a coat of cement plaster be applied directly upon the masonry of any parts of a chimney that are to be incased by a wooden partition or other combustible construction.

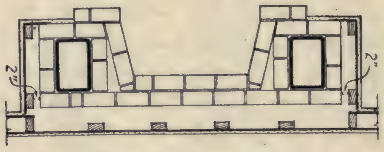


FIG. 11.—No wooden studding, furring, or lathing should be placed against the chimney. It should be set back as indicated in this figure and in fig. 12.

SMOKE TEST FOR LEAKAGE.

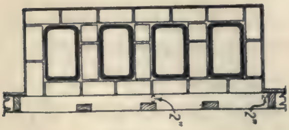


FIG. 12.

Every flue should be subjected to a smoke test before the heater is connected with it. This may be done as follows: Build a paper, straw, wood, or tar-paper fire at the base of the flue, and when the smoke is passing in a dense column tightly block the outlet at the top by laying a wet blanket over it. If leakage exists at any point, it will immediately become apparent by the appearance of smoke at the opening. Flues so tested frequently reveal very bad leaks into adjoining flues or directly through the walls or between the linings and the wall. When the smoke test indicates leakage, the defect should be remedied before the chimney is accepted for use. Remedying such defects is usually difficult, hence it is wise to watch the construction closely as it progresses. Many brick masons say that all flues leak. This is not true; every flue should be tight.

CLEANING AND REPAIRING THE FLUE.

If a smoke test shows no leakage and the flue is straight, a hand mirror held at the proper angle at the base affords a means of examination for obstructions. Usual causes of stoppage are broken tile leaning inward, mortar accumulations, loose bricks, bird's nests, partly burned paper, soot from soft coal, tarry deposits from burning wood, etc. A weighted bag of hay or straw attached to the end of a rope may be passed up and down the flue to clean it if there is not too great an offset in it.

FIREPLACES.

The use of the fireplace is a very old method of house heating. As ordinarily constructed fireplaces are not efficient and economical. The only warming effect is produced by the heat given off by radiation from the back, sides, and hearth of the fireplace. Practically no heating effect is produced by convection; that is, by air currents. The air passes through the fire, is heated, and passes up the chimney, carrying with it the heat required to raise its temperature from that at which it entered the room and at the same time drawing into the room outside air of a lower temperature. The effect of the cold air thus brought into the room is particularly noticeable in parts of the room farthest from the fire.

The open fireplace, however, has its place as an auxiliary to the heating plant and for the *hominess* that a burning fire imparts to the room. If one is to be provided, the essentials of construction should be understood and followed so that it will not smoke.

ESSENTIALS OF FIREPLACE CONSTRUCTION.

In order that satisfactory results may be obtained from an open fireplace, it is essential: First, that the flue have the proper area; second, that the throat be correctly proportioned and located; third, that a properly-constructed smoke shelf and chamber be provided; fourth, that the chimney be carried high enough to avoid interference; and fifth, that the shape of the fireplace be such as to direct a maximum amount of radiated heat into the room.

AREA OF THE FLUE.

The sectional area of the flue bears a direct relation to the area of the fireplace opening. The area of lined flues should be a tenth or more of that of the fireplace opening. If the flues are unlined the proportion should be increased slightly because of greater friction. Thirteen square inches of area for the chimney flue to every square foot of fireplace opening is a good rule to follow. For the fireplace shown in figure 13–A, the opening of which has an area of 8.25 square feet, there is required a flue having an area of 107 square inches. If this flue were built of brick and unlined it would probably be made 8 inches by 16 inches, or 128 square inches, because brickwork can be laid to better advantage when the dimensions of the flue are multiples of 4 inches. If the flue is lined the lining should have an inside area approximating 107 square inches. It is seldom possible to secure lining having the exact required area, but the clear area should never be less than that prescribed above.

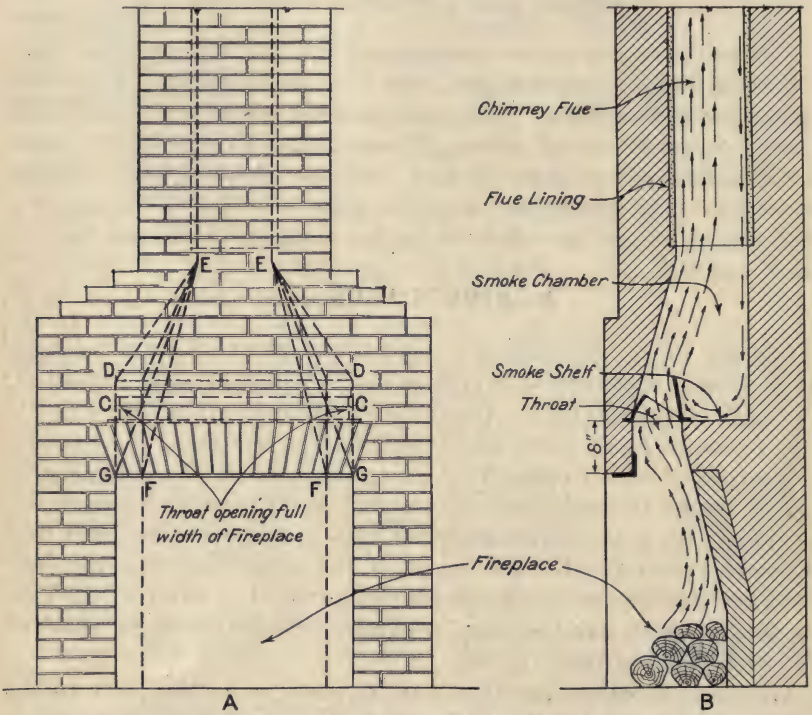


FIG. 13.—A. Top of throat damper is at DD, smoke shelf at CC. Side wall should not be drawn in until the height DD is passed. This assures full area. If the drawing in is done as indicated by lines EF and EG, the width of the throat becomes less than the width of the opening and causes the air currents to pile up in the corners of the throat, resulting frequently in a smoky fireplace. B. Correct fireplace construction.

Failure to provide a chimney flue of sufficient sectional area is in many instances the cause of an unsatisfactory fireplace. The cross section should be the same throughout the entire length of the chimney. Do not contract the flue at the chimney top, for that would nullify the larger opening below; if it is necessary to change the direction of a flue the full area should be preserved through all turns and bends, and the change should be made as gradual as possible.

THE THROAT.

In figure 13–B is shown the throat, the narrow opening between the fireplace and the smoke chamber. Correct throat construction contributes more to efficiency than any other feature except proper flue design. A flue twice as large as is necessary brought straight down to the fireplace without constriction at the throat would result in a poor draft, for the draft does not depend upon the largeness of the flue but upon its proper proportioning to the fireplace and throat. The arrows indicate the upward flowing currents of warm air which are thrown forward at the throat and pass through the smoke chamber into the flue on the inner side. This rapid upward passage of air causes a down current on the opposite side, as indicated by the descending arrows. The down current is not nearly as strong as the up current, but it may be of such force that if there be no throat to the fireplace (see fig. 14) to increase the velocity of the upward current by constricting it, the meeting of the two currents will result in smoke being forced out into the room. Thus it frequently happens that a fireplace has an ample flue area and yet smokes badly. The influence of the throat upon the upward and downward air currents is shown in figure 13–B.

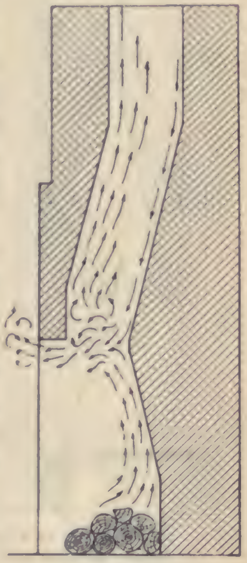


FIG. 14.—Fireplaces constructed like this without throat will very likely smoke.

The area of the throat should not be less than that of the flue. Its length should always be equal to the width of the fireplace opening. (See fig. 13–A.) The sides of the fireplace should be vertical until the throat is passed. (DD in fig. 13–A.) Above the throat the sides should be drawn in until the desired flue area is attained. The throat should be set 8 inches above the location of the lintel, as shown in figure 13, A and B. The wrong way to place the throat damper is shown in figure 15. The throat should not be more than 4 or 5 inches wide. The lesser width is a safe standard.

If a damper is installed the width of the brick opening at the throat will depend upon the width of the frame of the damper, the width of the throat proper being regulated by the hinged cover of the damper. If the throat damper is omitted the opening should be 4 inches, as shown in figure 16. The smoke shelf should not be bricked up but should conform to the dotted lines. The depth of the smoke shelf should be the same for a 2-foot as for a 10-foot fireplace opening.

Proper throat construction is so necessary to a successful fireplace that the work should be carefully watched to see that the width is not made more than 4 inches and that the side walls are carried up perpendicularly until the throat is passed, so that the full length of opening is provided. All masons do not appreciate these fine but necessary points. Many prefer their own and sometimes will ignore the proper methods. It is therefore advisable to inspect the work several times a day as it progresses and thus avoid poor results. When trouble is experienced in an existing fireplace that has ample flue area, it is usually found that the formation of the throat is the cause.

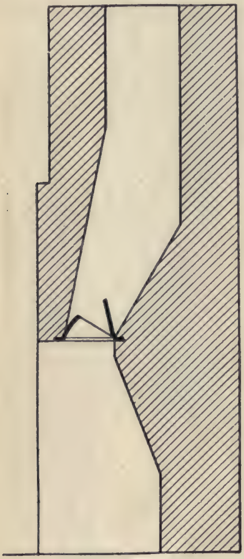


Fig. 15.—Wrong location for throat damper. The throat is so low that the accumulation of gases at the point constricted weakens rather than improves the draft with greater likelihood of a smoky fireplace. Note that the smoke shelf is bricked up. This is wrong.

SMOKE SHELF AND CHAMBER.

A smoke shelf and chamber are absolutely essential. The shelf is formed by setting the brickwork back at the top of the throat to the line of the flue wall. The shelf should be the full length of the throat. The depth of the shelf should be not less than 4 inches. It may vary from this to 12 or more, depending upon the depth of the fireplace.

The purpose of the smoke shelf is to change the direction of the down draft so that the hot gases at the throat will strike it approximately at a right angle instead of head on. Therefore the shelf should not be bricked up as shown in figures 15 and 16, but should be made as wide as the construction will permit at a height of 8 inches above the top of the fireplace opening.

The smoke chamber is the space extending from the top of the throat up to the bottom of the flue proper and between the side walls, which may be drawn in after the top of the throat is passed. The area at the bottom of the chamber is quite large, since its width includes that of the throat added to the depth of the smoke shelf. This space is capable of holding accumulated smoke temporarily in case a gust of wind across the top of the chimney momentarily cuts off the draft. Smoke might be forced into the room if there were no reservoir to hold it. The smoke chamber also lessens the force of the down draft by increasing the area through which it passes. If the walls are drawn inward 1 foot for each 18 inches of rise, friction is reduced and interference with the draft lessened. The walls should be smooth inside, for roughness seriously impedes the upward movement of the air currents.

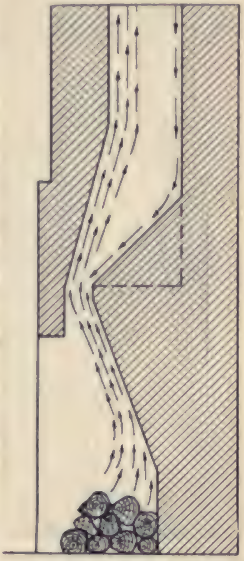


FIG. 16.—This construction without a throat damper directs the down draft so that it meets the up draft almost at the throat, which is more faulty than the construction shown in fig. 15, for there the lid of the damper deflects the down current.

SHAPE OF THE FIREPLACE.

The shape of the fireplace proper should be as indicated in figure 13–A. The back should pitch forward from a point a little less than half way from the hearth to the top of the opening, and the sides should be beveled as indicated. Straight back and sides do not radiate as much heat into the room.

THE THROAT DAMPER.

A properly designed throat damper affords a means of regulating the fire. The damper consists of a cast-iron frame with a lid hinged preferably at the back so that the width of the throat opening may be varied from nothing to 6 inches. There are a number of patterns on the market, some of which are designed to support the masonry over the fireplace opening.

A roaring pine fire requires a full throat opening, but slow-burning hardwood logs require but 1 or 2 inches of opening. Regulating the opening according to the kind of fire prevents waste of heat up the chimney. Closing the opening completely in summer keeps flies, mosquitoes, and other insects from entering the house by way of the chimney.

In houses heated by furnaces or other modern systems fireplaces without throat dampers interfere with even heating, particularly in very cold weather. An open fire must be supplied with air and the larger the fire the greater the quantity required; a fireplace with a width of 5 feet or more may pull air from distant parts of the house. This air that is heated at the expenditure of fuel in the furnace is carried up the chimney and wasted, but with a throat damper open only 1 or 2 inches a slow fire of hardwood can be kept going without smoking the room, thus reducing materially the waste of hot air.

PLACING THE THROAT DAMPER.

The throat damper should be as wide as the fireplace, so the side walls should not be drawn in until after the throat is passed. Smoke dampers with lid hinged at the back will help the smoke shelf to turn the down draft; if the lid is hinged in the center the downward and upward currents are apt to conflict. The placing of the damper varies with the type, but generally the bottom of the frame is built into the brickwork at the level of the top of the fireplace opening, forming the throat and supporting the masonry above it.

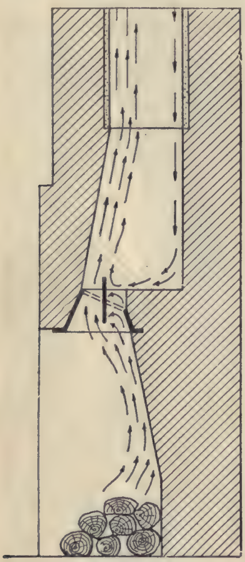


FIG. 17.—Smoke dampers with lids hinged in the center do not turn the up draft as well as do those hinged at the rear side.

SIZE OF FIREPLACE OPENING.

Pleasing proportions in the fireplace opening are desirable. The width should generally be greater than the height, but as 30 inches is about the minimum height consistent with convenience in tending the fire, a narrow opening may be made square. Three feet and a half is a good maximum for height of opening unless the fireplace is over 6 feet wide. The higher the opening the greater the chance of a smoky fireplace.

A fireplace should be in harmony with the rest of the room in proportions and details. This consideration and the kind of fuel to be used largely determine the size of opening.

Generally speaking the day of large farmhouse fireplaces capable of receiving cordwood is past. The tending of fires usually falls to the housewife, and cordwood is a heavier weight than she should handle and can not be stored near at hand. Cordwood cut in two is easily handled; so that a 30-inch width is about the minimum for farmhouses where wood is used for fuel. If coal is burned the opening may be made narrower.

DEPTH OF FIREPLACE OPENING.

Unless a fireplace with a 6-foot opening is made fully 28 inches deep, in order that large logs will lie well inside, the advantage of the wide opening is lost, for the logs will have to be split. A shallow opening throws out more heat than a deep one of the same width, but can take only sticks of smaller diameter; thus it becomes a question of preference between the greater depth which permits of large logs that burn longer and require less frequent replenishing and the shallower which takes lighter sticks and throws more heat.

In small fireplaces a depth of 12 inches will permit good draft if the throat is constructed as explained above, but a minimum depth of 18 inches is advised, to lessen the danger of brands falling out on the floor. Wire guards should be placed in front of all fireplaces. In general, the wider the opening the greater should be the depth.

THE HEARTH.

The hearth should be flush with the floor, for sweepings may then be brushed into the fireplace. An ash dump located in the hearth near the back of the fireplace is convenient for clearing ashes and other refuse from the hearth provided there is space below for an ash pit. The dump consists of a cast-iron metal frame, with pivoted cover, through which the refuse can be brushed into the ash pit below. The ash pit should be of perfectly tight masonry and provided with a tightly fitting clean-out door. If a warm-air flue, as described on page 27, is provided, the ash dump will have to be located near one side of the hearth instead of in the center.

THE JAMBS.

The jambs of the fireplace should be of sufficient width to give stability to the structure both actually and in appearance. For a fireplace opening 3 feet wide or less, 16 inches is generally sufficient; for wider openings similar proportions should be kept. Greater widths may be required to harmonize with the proportions of the rooms, and the above should be taken as a minimum.

FIREPLACE BACK AND SIDES.

The back and sides of the fireplace should be constructed of firebrick only. The bricks should be laid flat with the long sides exposed, for if placed with the face exposed there is danger of their falling out.

SUPPORTING IRONS.

In small fireplaces sagging of the arch over the opening seldom occurs, but in fireplaces over 4 feet wide it is not uncommon. It is due to insufficient support of the masonry. Except in massive construction there generally is not sufficient masonry at the sides of the opening to resist the thrust of arch construction; hence it is usual to support the masonry with iron, which, if too light, will sag. Too small an iron will become so hot that its tensile strength is lowered until it bends. A heavy flat bar at least one-half inch thick is sometimes used or a T-bar which has greater strength, but less metal; the wider the opening the heavier the bar required.

IMPROVING FIREPLACE HEATING.

A number of patents have been obtained for improvements in fireplace heating. Most of them, depending on the fact that hot air rises, deliver air heated in or around the fireplace through a register, located above the fire, into the upper part of the room, which is always the warmest part. Furthermore, they require a specially built chimney, precluding the installation of such a device in an existing fireplace. Unless fresh outside air is supplied there is no improvement in the warming of the room.

Patent No. 1251916, issued to Joseph Parsons, of Lakeville, Conn., and by him assigned to the United States Government, presents means of greatly increasing the efficiency of fireplace heating. The inventor's claim differs from other claims for improving fireplace heating in that the operation of his device depends upon the suction created in the chimney by the hot air rising from the fireplace and therefore makes possible the delivery of heated air through a register located at any place in the room or at the hearth. Furthermore, it permits of installation of one of the simpler types in an existing chimney.

For a fire to burn it must be supplied with oxygen. If a fire were built in a fireplace in an air-tight room it would go out as soon as the oxygen present had been consumed unless a down draft in the chimney supplied the needed air. As our fireplace fires do not go out so long as they are fed with fuel it is obvious that the required air supply is obtained from somewhere. Any one who has depended upon a fireplace to heat a room knows that the part of the room farthest from the fire is the coldest and that the temperature around the windows is especially low. In fact the harder the fire burns the colder it is at the windows. The fire must have air, and as cracks exist around windows and doors the air enters through them. The volume entering is equal to that passing up the chimney. This air comes from outside at a low temperature. Figure 18 illustrates how a fireplace fire supplies its needs. When it grows colder outside a bigger fire is made. The bigger the blaze the greater the quantity of outside air drawn into the room through every crack and crevice until, when the outside temperature gets below the freezing point, there is no comfort in the room beyond the immediate vicinity of the fire.

If a room were so tight that the air leakage were insufficient to supply a fireplace fire, it would not burn properly and would smoke. If a pane of glass were removed from a window cold air would rush in through the opening. If the glass were replaced and an opening of equal area be made through the chimney, as shown in figures 19, A and B, so that air could be admitted into the room as indicated by the arrows in the plan, figure 19–B, an equal volume of cold air would be drawn through this opening. As it comes into contact with the metal form the air becomes heated, so that when delivered into the room its temperature would be 100 degrees or higher, depending upon the radiating surface of the hearth, assuming an outside temperature of 32 degrees. (Tests by the writer have shown this temperature to be higher than 125 degrees.) If the chimney opening be closed and the pane of glass be again removed the temperature of the air entering through the window would be 32 degrees. It is obvious that the room will be more effectually heated when the air required for combustion is supplied at a high temperature than when supplied through cracks and crevices at a low temperature. All our homes should be made fairly tight for greater comfort in winter. In such a house, with doors and windows closed, the suction caused by the fire can thus be utilized to draw into the room outside air heated in passing through a metal flue on which the fire is burning.

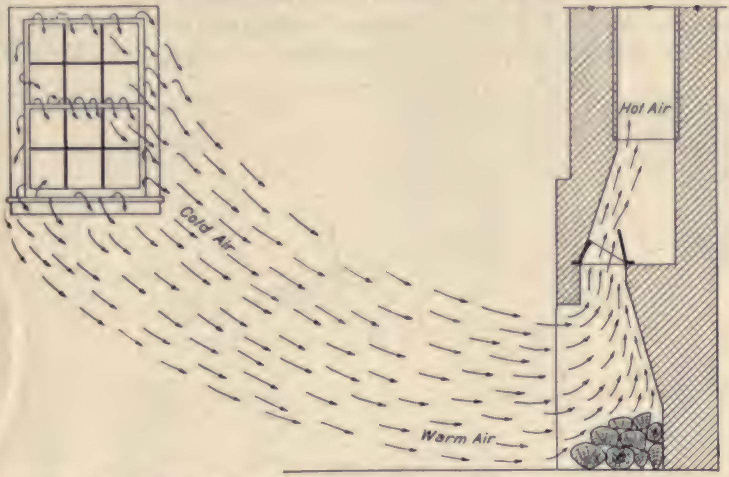
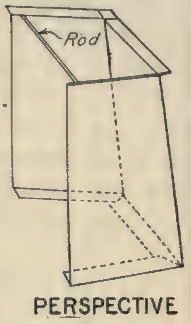


Fig. 18.—All air required for feeding the fire must pass through the room, entering through cracks around windows and doors and producing an uncomfortable temperature in all parts of the room except near the hearth.

The principle may be applied in various forms. Figure 19–A illustrates a simple form for use in connection with an outside chimney.

A piece of galvanized sheet iron is bent to the proper form and set into the fireplace so as to leave an air space between it and the back and sides of the fireplace. An opening to the outside is made by removing two or three courses of brick. Air enters through this, becomes heated by contact with the metal, and is delivered into the room at the sides of the fireplace, as indicated in the plan of figure 19–B. It immediately rises within the room, gives up part of its heat, and eventually whirls about and into the fire, as indicated by the arrows in figure 19–A. This form would not necessarily heat the entire room effectually; it would, however, supply heated air for the fire in volume sufficient to replace or materially reduce the quantity of cold



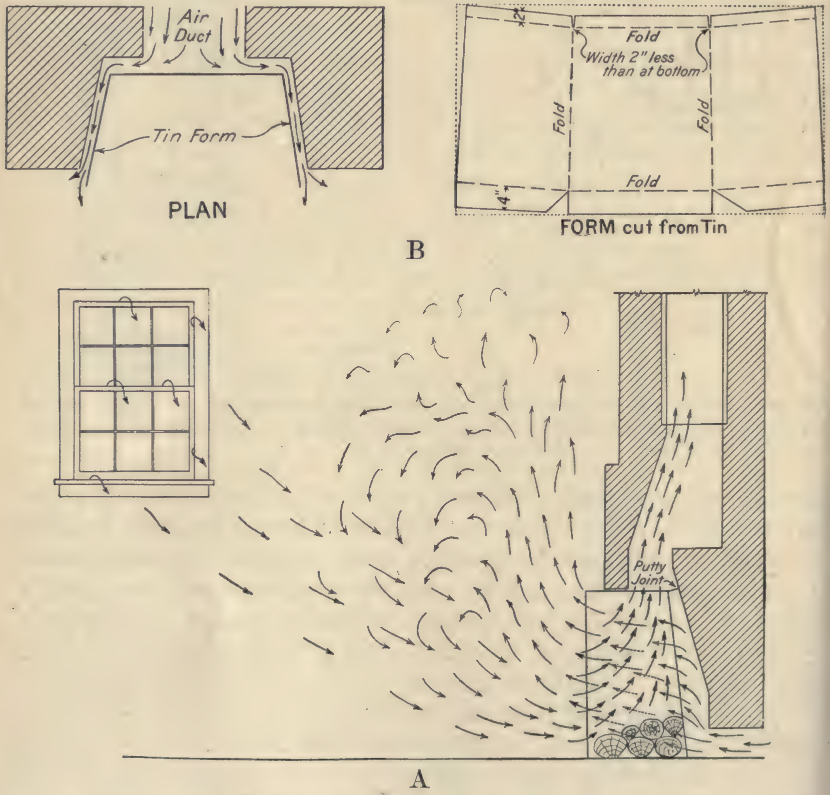


FIG. 19.—Simple form of warm-air flue for outside chimney. Air required for feeding the fire is brought in from the outside around a metal form set in the fireplace, with a space between it and the back and sides of the brickwork. As the cold outside air passes around the metal it becomes heated and is delivered into the room at a temperature much higher than where it is pulled in through window and door cracks. The result is a much more comfortable room.

air which would otherwise enter through window and door cracks. With a brisk fire burning, a rush of warm air can be felt 6 or 8 feet away from the fireplace.

This simple form may be built as follows: A piece of roofing tin about 6 inches wider than the height of the fireplace opening, with length equal to the width of the opening plus twice the depth of the side, should be secured. It should then be marked and cut as indicated in the form (fig. 19-B), and bent into a shape similar to that shown in the perspective, same figure. When placing it, there should be a space left between the tin and the brickwork at both back and top. The back and sides at the top should be bent back 2 inches to meet the brickwork. The crack or joint should be tightly closed with asbestos or furnace cement. The tin form rests on the 4-inch bottom flange. The joint here can be made tight by placing a few brick on the flange and covering with ashes, or a metal plate cut to the proper shape may be laid upon and preferably riveted to the lower flanges of the back and sides. The form should be as high as the opening and the metal sides should project about 3 inches beyond the jambs, so as to throw the heated air well out into the room. A one-fourth-inch rod

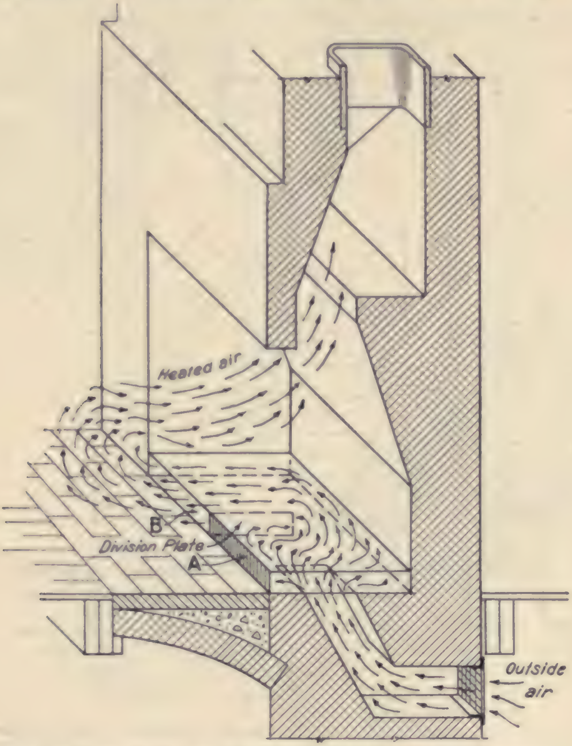


Fig. 20.—Simple form of warm-air flue for inside chimney.

placed across the top of the tin form directly under the arch iron of the fireplace assists in holding the top of the tin firmly against the brickwork.

Figure 20 shows a simple form for use with an inside chimney. A hole may be cut in the hearth on one side and connected with the outside by means of a passage through the chimney foundation. The manner of providing this passage will depend upon the construction in the particular case. A galvanized sheet-metal box with a division plate extending part way through it is set on the hearth. The side over the opening is bent down in front, as at A, so that the entering cold air must pass to the rear around the division plate and then out into the room in front of the hearth, as at B. The fire, on top of the metal flue, heats the air issuing at B as it flows under it. Figure 21 shows an improved form in which the flue and division plate are extended up the back of the fireplace. This presents considerably more radiating surface, so that the air can be heated to a higher temperature. The air issuing from this flue at B is discharged farther out into the room. If there is a cellar under the floor a metal duct must

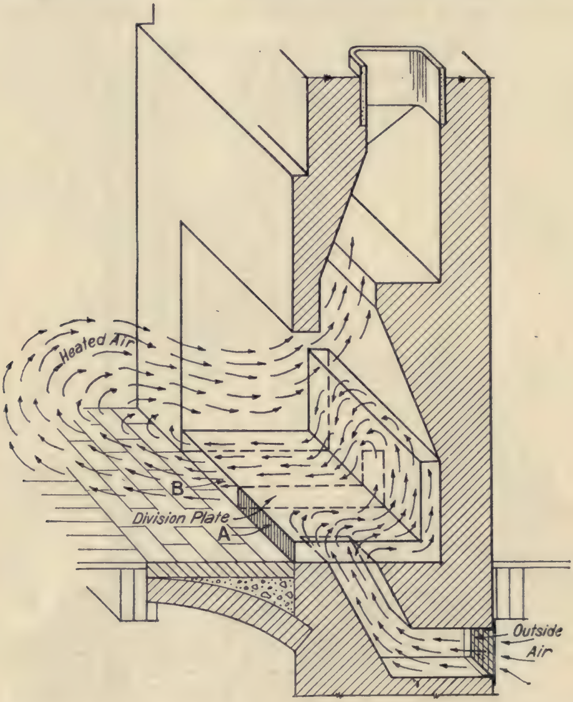


Fig. 21.—Improved form of warm-air flue for inside chimney. The increased radiating surface obtained by conducting the metal flue up the back of the fireplace heats the air to a higher temperature so that it is delivered into the room farther from the outlet duct.

be employed to bring fresh air from an opening in the outside wall, just below the joists, to the hole in the hearth. Cellar air should never be sucked through the flue. All openings under the house or through the wall should be screened to keep out rats and mice, and doors should be provided to close the openings entirely if desired.

Figure 22 shows a more elaborate installation. This insures very satisfactory heating with a fireplace fire. The piece A B C D of galvanized metal has a rectangular cross-section. Two or three courses of brickwork are omitted and the metal duct is set into the fireplace, so that radiation from the fire impinges upon its surface from B to D. The air entering from outside at AE is heated as it passes through the flue behind and under the fire and is carried through another rectangular duct under the floor to a register located in a far part of the room. Out of this register air in large volume is discharged at a high temperature. This air heats the far part of the room and other parts as it travels from the register upward and through the room to the fireplace. Thus the fireplace heats the room by convection of heat as well as by radiation, and all parts of the room are more comfortable than if radiation alone were depended upon. A test of an installation similar to that shown in figure 22 was made by the writer. The fireplace and suction flue

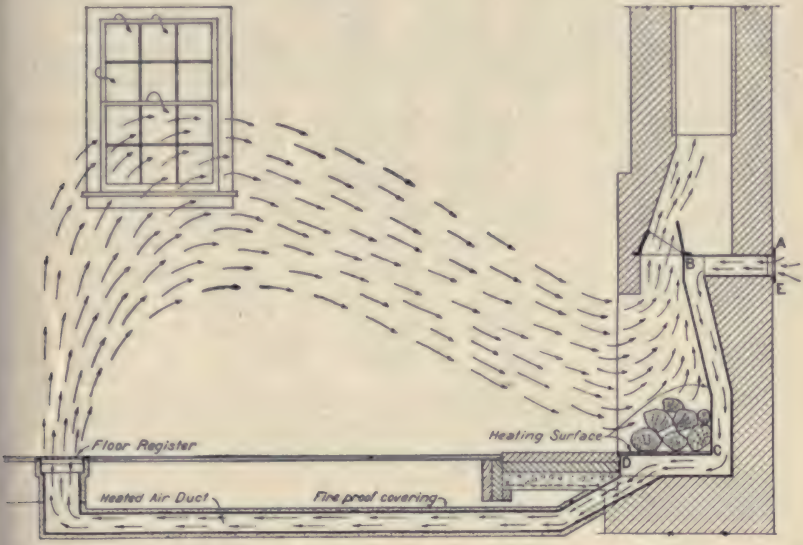


Fig. 22.—Improved form of warm-air flue with floor register. This method increases the efficiency of fireplaces many times by delivering the air that must be supplied to the fire into the room at temperatures of 100° and higher, depending upon the form and extent of the heating surface at the back of the fireplace, and delivering it to the coldest part of the room so that heat is distributed more effectively and the entrance of cold air around windows and doors is reduced to a minimum.

were built in a cabin measuring 24 feet square by 9 feet high. The test was conducted late in November on a night when the outside temperature was 24° F. It was the first fire built in the fireplace in that season, consequently all the materials of the building were cold. The room was practically airtight; very little leakage could be felt around the windows. A temperature of slightly over 100° was recorded directly over the register, in the center of the room it was 72°, and in the farthest corner a thermometer, hung about 18 inches from the wall between two windows, showed 65°.

Thus the efficiency of fireplaces may be materially increased, the degree depending upon the character of the air duct installed. Even in the simple types the air required to make the fire burn enters the room at a higher temperature at the floor instead of around windows and doors at a low temperature; windows and doors may therefore be made tight, so as to reduce the cold-air leakage. The type with a register in the far part of the room supplies heat to parts of the room or to an adjoining room, which would receive little heat if radiation only were relied upon. This means of improving fireplace heating is particularly adapted to small houses in the South, where the open fire is the most common method of house heating. As the simple types require only galvanized sheet metal bent at right angles, it is within the means and ability of many to supply themselves with flues of their own making.

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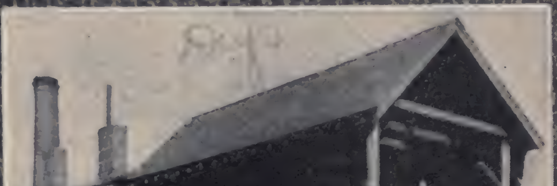
FARMERS' BULLETIN 1231

UNITED STATES DEPARTMENT OF AGRICULTURE

DRYING CRUDE DRUGS



THE application of a few fundamental principles of drying would result in making more marketable a considerable portion of the crude-drug materials that are gathered.

Success in drying depends chiefly upon the careful control of temperature and the flow of air.

In this bulletin two driers are described and the method of construction presented in detail. Either may be constructed by anyone familiar with the use of carpenter's tools from material which is everywhere available. The manner of drying is described and also the subsequent storage of the dried material.

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief
Washington, D. C. Issued November, 1921

DRYING CRUDE DRUGS.

G. A. Russell, *Expert, Office of Drug, Poisonous, and Oil Plant Investigations.*

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DRYING IS AN IMPORTANT PROCESS in the production of crude vegetable drugs for the market, and material that has been carefully gathered and harvested can be made unmarketable by improper methods of drying or curing. After the material is gathered, even a little care in drying will more than repay the collector for the work and expense involved. It must be understood, however, that poor material already in a moldy, partly decayed, or otherwise unsatisfactory condition can not be made into a good product by any amount of care in drying.

The appearance of crude drugs is often a criterion of their market value; therefore the careful producer will so control the drying operations as to produce the best-appearing drug at the minimum expense.

PRINCIPLES OF DRYING.

The object of drying is to remove sufficient moisture from the product to insure good keeping qualities. The removal of moisture from green drug plants prevents molding, the action of enzyms, and chemical or other changes which are brought about by the presence of excess moisture. To obtain satisfactory results in drying such plants, provision must be made (1) for the continuous flow of air at a suitable rate through the drying material and (2) for the control of temperature.

AIR FLOW.

Moisture to be removed from the plant tissues of green drug material must be converted into water vapor, which in turn must be taken up by the air. When in free circulation the air rarely ever becomes entirely saturated with water vapor and is practically always capable of absorbing more. If, however, the air is not in free circulation for any reason, it eventually becomes saturated with moisture and will not take up any more. To obtain proper drying, therefore, it is necessary to keep the air in motion, constantly bringing fresh volumes of air into contact with the material being dried. If, however, the air is kept in motion, fresh volumes are constantly brought into contact with the drying material, and evaporation from the material is not retarded but hastened.

During the drying process the material may become infected with molds, may change color, and may otherwise deteriorate, but it will eventually become thoroughly dry; that is, it will reach a condition in which moisture in the tissues is no longer converted into water vapor and taken up by the air.

Careful attention to the rate of air flow is important, particularly at the beginning of the drying operation. The moisture contained in the interior tissues of the drug reaches the surface relatively slowly. Therefore, if the surface moisture is removed more rapidly than it can be replaced by interior moisture the outer layers of cells will tend to dry out and become hard while the interior is still moist. This condition is likely to occur when large volumes of air are circulated, and especially if the air is circulated while warm. The hardening of the outer portion of the drug is undesirable, especially with root drugs, since deterioration is likely to take place soon after the material is removed from the drier, because of the interior moisture.

TEMPERATURE.

At any specified temperature a given volume of air can hold only a definite quantity of water vapor. The raising or lowering of the temperature increases or decreases the amount of moisture that this volume of air can hold. In the drier illustrated in figure 6 each compartment contains approximately 200 cubic feet of air. Under ordinary atmospheric pressure the air in a single compartment at 32° F. can hold slightly less than 1 ounce of water vapor; at 70°, 3.54 ounces; at 100°, 8.9 ounces; at 150°, slightly over 2 pounds; at 200°, almost 6 pounds; and at 212°, 7½ pounds.

Since the air always contains some moisture, it must not be inferred that 200 cubic feet of air will at any given temperature absorb the maximum quantity of water vapor which it can contain at this temperature. For example, 200 cubic feet of air at 100° F. may already contain 2.5 ounces of water vapor, and since this volume of air can only hold 8.9 ounces when entirely saturated the difference between 8.9 ounces and 2.5 ounces, or 6.4 ounces, is the quantity of additional water vapor which 200 cubic feet can absorb. Furthermore, the air passed through a drier is never allowed to become saturated, even as it approaches the outlet, for if it does become saturated with water vapor it deposits some of its moisture on reaching a lower temperature than the one at which it became saturated. In that case the contents of the upper trays in the drier would become wet with external moisture and would not dry out satisfactorily until the lower trays had become dry.

After absorbing the first 60 per cent of its moisture-holding capacity the air takes up moisture very slowly to the point of saturation. It is advisable to provide such a flow of air through the drier as will contain approximately 60 per cent of its moisture-carrying capacity as it leaves the outlet. Later on, as the drug becomes more and more dry, the air will absorb less and less additional water vapor, and at the end of the drying operation will contain no moisture evaporated from the drug. The material is then dry.

For the proper drying of crude drugs the upper range of temperature varies with the product to be dried, but it should never exceed 170° F., the temperature at which 200 cubic feet of air can hold 3.22 pounds of water vapor. This temperature should not be reached, however, until the drug is nearly dry; in fact, better results are usually obtained by maintaining a temperature not over 120° F., which should be reached only after the drug has dried for some time. Too high a temperature at the beginning brings about the same condition as the circulation of too great a volume of air, namely, the hardening of the surface tissues, with a retarding and ultimate stopping of evaporation of the interior moisture.

Control of the temperature and regulation of the air flow are the two main principles of drying. The most efficient method is to combine the two and force heated air over the material at such a rate that it will remove the moisture from the surface just as rapidly as it comes from the interior of the material being dried. To determine this point is a matter largely of experience and practice. To pass beyond it causes the moisture to be rapidly extracted from the outside tissues of the drug, so that they become hard and thus retard or often completely stop the evaporation of the interior moisture. In addition, the heat which should be used to assist in vaporizing the moisture is lost, with a consequent increase in the cost of drying.

Fresh crude drugs should be dried only at such a rate that the loss of moisture is constant and relatively slow. It is better to dry them over a long period of time at a slow rate of evaporation of the interior moisture than to dry them over a short period with a resulting product which is easily subject to deterioration or which is "off" in color. The increased price for the article of higher quality will more than compensate for the additional expense involved in the slower drying.

Control of the drying operation is determined only by the nature of the material to be dried and the desired appearance of the finished product. It may be generally stated, however, that leaf and herb drugs should be dried at moderate temperatures and root drugs at somewhat higher temperatures, the degree of heat to be used depending upon the condition of the green material. Flowers require low temperatures, whereas barks can often be dried at relatively high temperatures. Drugs in which the value depends on aromatic principles that are easily volatilized must be dried at a low temperature, in order that the volatile principle may not be lost through evaporation.

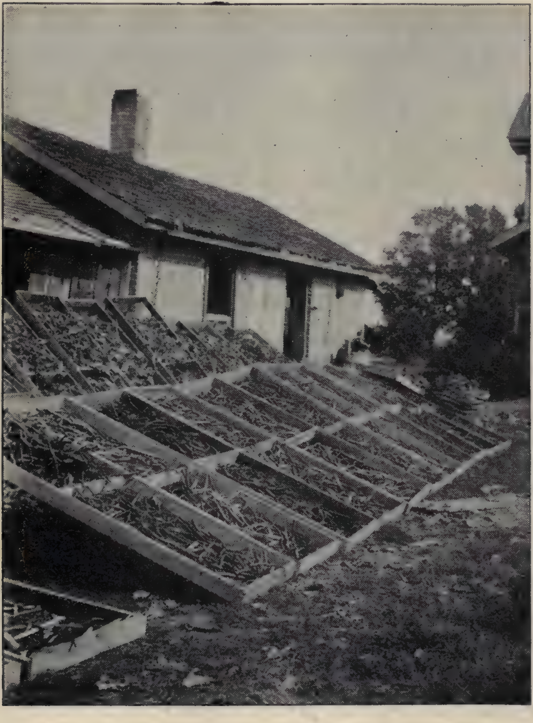
FIG. 1.—Burdock roots being dried in the sun.

METHODS OF DRYING.

Crude drugs can be dried either in the air or by means of artificial heat. When dried in the air, either sun-drying or shade-drying is employed, depending upon the type of material and the appearance desired for the finished product. The term "sun-drying" is self-explanatory. This method can be employed only with drugs in which the quality or appearance is not unfavorably affected by the action of direct sunlight. It is the least expensive, of course, of any method. Figure 1 shows a quantity of burdock roots being dried in the sun. The roots are split and then spread on trays to facilitate handling night and morning or on rainy days. Dried in this manner burdock root is in first-class marketable condition. The period of drying of the burdock shown in the illustration extended over several days, and as no rains occurred during that time the trays were left in the sun continuously from early morning until just before sundown, being moved about as required to face the sun.

In shade-drying the direct effect of the sun's rays is eliminated. Shade is used to protect the material from the action of direct sunlight, which destroys the natural color of the drug. Certain aromatic drugs, such as sage, peppermint, and wormwood, are perhaps better in quality and appearance if dried in the shade without the use of artificial heat, unless the heat is carefully controlled and kept relatively low. Figure 2 shows a quantity of wormwood herb being dried in the shade. The fresh herb was spread in thin layers on wires strung across the driveway of a double corncrib. The sun's rays were shut off by the roof of the corncrib and the slat construction allowed a free circulation of air. After several days the herb was completely dry and had a pleasing silver-green natural color. The expense of drying was very slight.

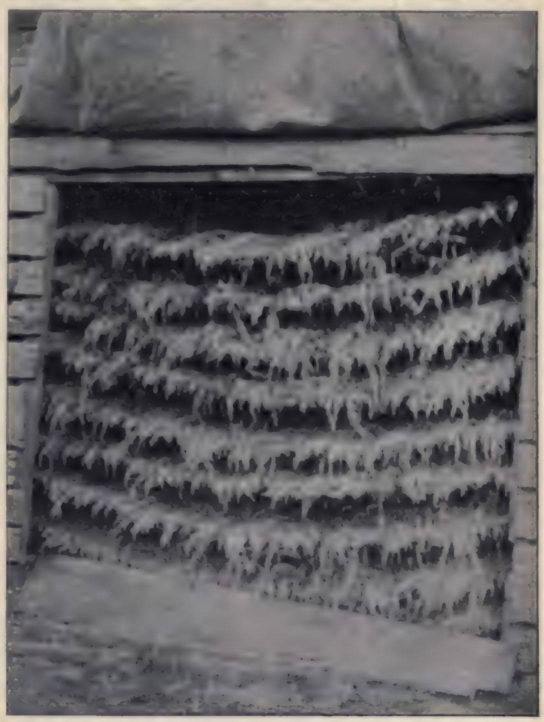

FIG. 2.—Wormwood herb being dried in the shade.

All things considered, drying by means of artificial heat is probably the most satisfactory method, and some of the most practical ways of doing it are described in this bulletin. A careful workman can safely use artificial heat to dry even the most delicate aromatic drugs. Where large quantities are to be dried in a relatively short period of time artificial heat becomes a necessity. If, however, only small quantities are to be dried air-drying is the cheapest and perhaps the most practicable method, but some arrangement should be provided whereby artificial heat may be employed during long rainy periods or when other conditions are not favorable for air-drying.

DRYING EQUIPMENT.

The equipment necessary for the proper and successful drying of crude drugs depends upon the nature of the drug to be dried, the weather conditions during the period of drying, and the quantity of material to be handled.

Crude drugs fall naturally into one of the following classes: Leaves, herbs, roots, rhizomes, barks, fruits, and flowers. Leaf drugs consist either of the whole leaf or the leaf and a small portion of the upper end of the stalk. Herbs consist of the portion of the plant above ground and may contain flowers or fruits. Root drugs consist of the root of the plant, either whole or with the bark removed. Rhizomes are the underground stems, which are sometimes improperly called roots. Barks consist of the bark either of the aerial part of the plant or of the root. The latter are designated as root barks to differentiate them from other barks. Fruit drugs consist of the whole fruits, whereas seed drugs are only the seed of the fruit. Flower drugs consist either of the whole flower or of certain portions of the flower.

The producer of crude drugs, whether he is a collector or grower, must take into account all these classes of drugs, since in all probability he will dry some of each class. Because of this range of materials and the variation in weather conditions over the long period of time in which these various drugs mature, it is best to provide a drying apparatus in which artificial heat can be employed when necessary.

It is assumed that the material to be dried comes to the drying house in proper condition; that is, free from foreign matter, such as dirt, stones, and sticks, and that after drying it can be put into shape for shipment with very little extra work, such as cleaning or sorting. Some drugs must be sorted or graded, and this can be done either before or after drying, depending upon the choice of the producer.

Material to be air-dried in the sun, can be spread on trays, boards, sheets of burlap, papers, or any other suitable and convenient material. If the lots to be dried are not large, they can be spread on the southern roof of a low building, from which they can easily be removed at night or in the event of rain.

For air-drying in the shade, some arrangement should be provided whereby the material can be left until dry. This can be effected in two ways: The material can be spread out on some sort of convenient tray or it can be hung on wires or strings, the method depending upon the nature of the products to be dried. When the whole herb is to be dried it has been found very convenient to hang it on wires stretched in an attic or in a building where there is a good circulation of air. In the case of belladonna, which was dried in the experiments of the writer before the leaves were removed, the herb was hung by catching the wire at the union of the lowest leaf and the stalk. It was found that each linear foot of wire accommodated 1¼ pounds of green herb and that it was possible to string the wires 1 foot apart, having each tier of wires 2 feet from the next tier.

below, which arrangement allowed for plenty of air and also economized all the space. However, it is a better plan to use trays. These can be supported in any convenient manner and can be used for any drug. They are convenient to handle, are easily stacked away when not in use, and if properly constructed will last for years. The construction of trays is described later.

It is not advisable to construct a drying house for air-drying alone, but rather to make one in which artificial heat can be supplied whenever necessary. The drying house shown in figure 6 can be used in this manner. The drying house illustrated in figure 3 was constructed for air-drying only. The numerous openings in this building allow for plenty of air circulation, but they also admit so much light that the drug loses its color by the time it is dry. A much better appearing drug could be obtained by making the openings narrow and fitting them with doors so that light could be shut out but air admitted. The slat ventilators in the peak of the building are of prime importance, for they furnish a means of allowing air circulation even when the windows are closed.

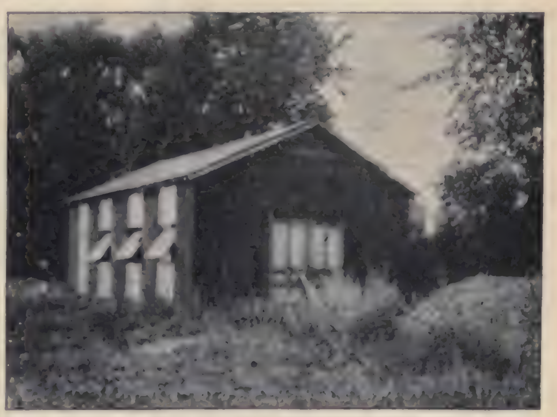

FIG. 3.—A drying house constructed for air-drying only.

DRYING WITH ARTIFICIAL HEAT.

There are numerous drying devices on the market which are available to the producer of crude drugs. Nearly all these, however, are intended primarily for drying fruits or vegetables or are designed to fit into large-scale factory operations. Any one of the fruit or vegetable driers could probably be utilized for drying crude drugs. If one of these driers is available and can be made to operate satisfactorily, the producer's drying problem is greatly simplified. The usual type of cook-stove drier has too small a capacity to be of any great use in drying large quantities of crude drugs. Such a drier could be used to advantage for small lots, especially of roots or seeds. Large driers, such as those described in Farmers' Bulletin 984, "Farm and Home Drying of Fruits and Vegetables," if they are available, can be used. The type of drier described in Bulletin 984 under the heading "A prune tunnel evaporator" is very efficient and can readily be adapted to the drying of crude drugs. Likewise, tobacco-drying barns and other similar structures can be remodeled with little effort into efficient driers for drugs. If, however, a drying apparatus is to be constructed especially for the purpose of drying crude drugs, one of the following types is recommended.

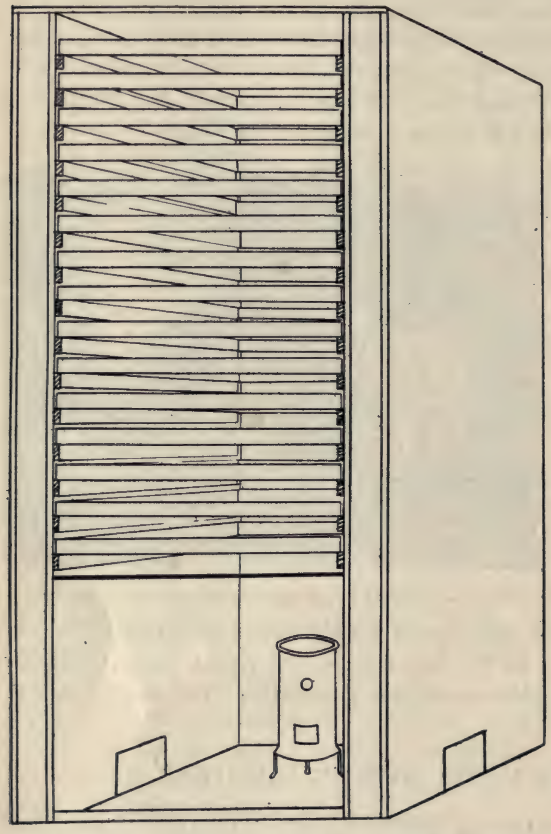

FIG. 4.—Plan of a small stove drier in perspective, with one side removed to show the arrangement of the stove and trays.

SMALL STOVE DRIER.

A drier of the stove type can be constructed at home at very little cost, and if the work is carefully done the drier will last for many years. A sketch of such a drier is given in figure 4. This drier is designed primarily to be heated by means of an oil stove. If a stove is used which burns wood or coal, the design is the same, but the dimensions are increased to meet the conditions. The drier is designed to accommodate 15 trays, each 3 by 3 feet; but more trays can easily be added if desired and if warranted by the available supply of heated air. A framework of 2 by 4 material is made in the form of an oblong box of such a size that the inside measurements will readily admit a tray 3 by 3 feet, allowing at least half an inch on every side of the tray for ease in inserting and removing from the drier. Tongue-and-groove lumber is nailed on the outside as well as on the inside of this 2 by 4 box frame; that is, it is sheeted up on both the outside and inside, thus forming an upright oblong box with open ends having a dead-air space in the walls. One side of the upright box is closed with a tightly fitting door, which reaches from just below the bottom of the lowest tray to just above the top of the uppermost tray. This door can be constructed to swing on hinges or it can be removed entirely whenever it is desired to insert or remove trays from the drier. The top of the box is closed by means of tongue-and-groove lumber, and in it are arranged small hinged doors which are operated as ventilators. This top does not contain a dead-air space. At the bottom of the drier, on two opposite sides, sliding doors are so arranged as to control the inlet of air. The inside of the drier is covered with tin up to the support of the bottom of the first tray. Three inches under the first tray is a piece of sheet iron or tin, arranged so that it comes over the top of the stove and prevents the hot air of the stove from coming directly into contact with the material in the lower tray.

The trays are made of strips of lumber 2 inches wide and three-fourths of an inch thick nailed together so as to form a framework 3 by 3 feet, outside dimensions. To this framework wire netting of suitable mesh is fastened with staples and answers all purposes except for the drying of small seeds. Thin wooden strips are nailed around the framework over the netting, forming a protection which keeps the netting from tearing loose and also supplying a means by which the tray can easily be slid into and out of the drier. The trays are supported on cleats of wood 1 inch thick, 2 inches wide, and slightly less than 3 feet in length, firmly nailed to the sides of the drier. The drier is designed to be used within a room or shed where it is protected from the elements.

By proper manipulation of the air inlet and of the ventilators a drier constructed as outlined will give excellent service at little expense.

The total drying area of this type of drier is approximately 132 square feet, and it will accommodate 75 pounds of green leaf drug, such as belladonna or henbane. The capacity of the drier when filled with roots, such as burdock or dandelion, is approximately 150 pounds of green material. The length of the period of drying and the oil consumption will depend on the nature of the material to be dried, the temperature of the air, and the degree of heat from the stove. Experience will soon teach the attendant how to operate the stove and the vents in the drier so as to obtain the proper rate of drying at the minimum expense of time and fuel.

LARGE-TYPE DRIER.

For operators drying as much as several hundred pounds of green crude drugs a day a large commercial-sized drier must be provided. A very satisfactory type of drier, that will dry in approximately 24 hours 750 pounds of leaf drug, such as belladonna or henbane, or 1,500 pounds of root drug, such as burdock or dandelion, is illustrated in figure 5. This drier is in operation at the present time, and is giving very satisfactory results, both as to the appearance of the finished product and the cost of the operation.

A drying house that will accommodate approximately 1,000 pounds of green leaf drugs or a correspondingly larger weight of green roots is illustrated in perspective in figure 6. This drying house is 14 feet 6 inches in length, 11 feet wide, and 10 feet 2 inches in height to the eaves. The end walls of the house are constructed of the usual 2 by 4 studs, sealed on the outside with ¾-inch ship-lap and on the inside with ¾-inch tongue-and-groove lumber. Building paper is nailed to the 2 by 4 inch studs, both on the outside and the inside, before putting on the boarding. The interior of the drier is cut into six compartments by partitions that extend from the floor to the line of the eaves. The partition that extends lengthwise through the center of the building is constructed of 2 by 4 inch studs, to which is nailed ¾-inch tongue-and-groove lumber, making the total width of the partition 5½ inches. The partitions that extend crosswise of the building are constructed of 2 by 4 inch studs so spaced in a staggered row as to make an 8-inch partition over all after the ¾-inch tongue-and-groove lumber has been nailed on. These 8-inch partitions are made thus wide to allow the easy opening of the heavy door of any one compartment without interfering with the adjoining compartment. If the partitions are narrower, the door of the compartment can not be made to swing open a sufficient distance to allow the removal of the trays without first opening the door of the adjoining compartment on the side nearest the door's hinges. Each of the six compartments is 4 feet 1 inch by 5 feet 1 inch, inside measurements. The top of each compartment is floored over with ¾-inch ship-lap or tongue-and-groove lumber on the upper side of the 2 by 6 inch stringers which form part of the framework of the building. Hinged doors 3 by 3 feet are set into this flooring over each compartment and so arranged as to be easy of manipulation by means of pulleys, with a rope which is run to the out-

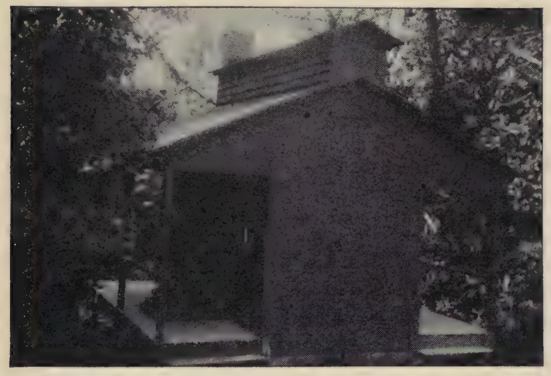

FIG. 5.—Drying house constructed for both air-drying and artificial heat.

side of the building. The flow of air through the material can be partially controlled by regulating these doors. The floor of the entire building is composed of wire screen of quarter-inch mesh nailed to 2 by 6 inch stringers, conveniently spaced so as to support the partitions and also form part of the framework of the building.

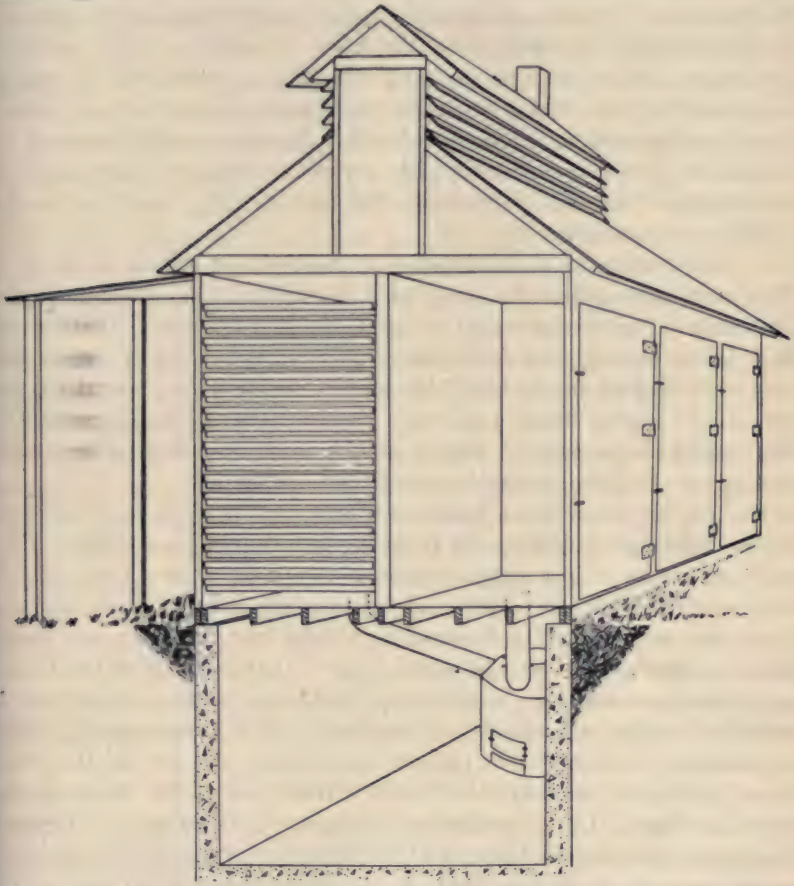

FIG. 6.—Plan of a commercial-size drier in perspective. The arrangement of the trays is shown in one compartment. The side roof on the right is not shown.

The compartments are large enough to accommodate trays 4 by 5 feet in size, outside dimensions, and each compartment holds 17 trays placed one above another, 6 inches being allowed from center to center of the tray supports. This is as great a number as can conveniently be loaded and placed in the drier and is also the maximum number which will permit proper drying without slowing down the drying on the upper trays. The trays are supported in the drier on strips 2 by 2 inches by 5 feet, securely nailed to the side walls of the compartments.

The door of each compartment is made to fit snug against the frame, having a bevel edge which meets a similar bevel on the door frame. Strips of felt nailed on this bevel help to make a tight union between the door and the frame. The door is constructed of two thicknesses of tongue-and-groove lumber nailed together diagonally to give strength and with a double layer of building paper between the two. A door thus constructed will be approximately 1¾ inches thick and will be strong, owing to the diagonal construction. Each door is supported on three 5-inch strap hinges securely screwed or bolted on. Two or more bolt locks or locks similar to those used on cold-storage ice-room doors keep the door tightly closed while the drier is in operation.

A fixed ventilator is constructed in the roof, as shown in figure 6. This ventilator allows the ready exit of the warm moisture-laden air after it has passed through the stack of filled trays and the control door in the ceiling over each compartment. Wire of any convenient mesh is nailed on the inside of the fixed ventilator, to prevent the entrance of birds or small animals. The roofs of the building and of the ventilator are covered with a good grade of roofing paper, metal roofing, or shingles, as may be convenient or desired.

The drying house is so designed that a roof is built on either side of the building, extending out from the building at least 6 feet. This roof has a very slight slope, so that at the outer or eaves side it will not interfere with the removal of the top tray. These roofs serve to keep rain and sun off the contents of the trays as they are being filled or emptied. It will be noted (fig. 5) that the roof of the building proper extends over a sufficient distance to make a cover, under which the trays are filled and emptied. This arrangement, while satisfactory, is wasteful of material and space, for not all the space from the top of the trays to a point directly above the doors on the roof is utilized. In the particular drying house illustrated in figure 5 the space not occupied, because of the design of the building, amounts approximately to 35 per cent of the cubic capacity of the entire building. This waste space is saved in the design illustrated in figure 6.

The heating arrangement for the drying house consists of a hot-air furnace. This is placed beneath the center of the building in a cellar or basement, and hot-air pipes run from the furnace to the center of each compartment. Pipes 8 inches in diameter supply heat to the middle compartments, while the end compartments are supplied by 12-inch pipes. Over the outlet of each hot-air pipe a piece of sheet iron 2 by 2 feet is placed about 6 inches from the floor level.

This deflects the stream of heated air and causes it to spread throughout the compartment. It also keeps the hot air from coming into direct contact with the material in the first tray. Each hot-air distributing pipe is fitted with a damper, by means of which the operator can regulate the flow of heated air supplied to each compartment and close off the heat from any compartment when desired. The smoke flue extends from the furnace to one end of the building, where it makes a half turn and enters the chimney on the opposite end. By extending the flue, as indicated, considerable heat is obtained by radiation which otherwise would be lost. The nature of the floor under the compartments permits the easy utilization of the heat from the flue as well as the heat which radiates from the body of the furnace. A suitable cold-air intake runs from the furnace to the outside of the basement. The chimney is constructed of brick, hollow tile, clay drain pipe, or any suitable material.

The basement is of the same size as the building, outside dimensions. The walls are thick enough to make a substantial structure, and may be built of any suitable material, although concrete is to be preferred. There is enough space for the furnace and for the storage of a small quantity of coal.

The drying house illustrated in figure 5 is on a hillside. This allows for the construction of a basement with low cost for excavation and also permits ready access from the ground level to the drying trays. If no such natural advantage can be utilized, the drying house can be placed over an excavation sufficiently deep to bring the floor of the building approximately 8 inches above the ground level, and a stairway can be built in an excavation that leads to a door set in the wall of the basement. A covering similar to the outside cellar door of a dwelling house prevents rain, snow, or refuse from entering the stairway and also tends to prevent the loss of heat by radiation.

DRYING TRAYS.

Trays suitable for use in a drying house like the one just described are easily constructed. They are 4 by 5 feet, outside measurements, and consist of a framework of ¾-inch wooden strips 2¾ inches wide, with an additional similar wooden strip nailed crosswise midway of the longest side of the tray. The bottom is a screen of any small mesh. For most drugs ¼-inch mesh is desirable, but where seeds are to be dried a smaller mesh is necessary; a mesh greater than quarter inch is not recommended. After the screen bottom has been stapled to the framework a strip of wood three-quarters by three-quarters of an inch is nailed over the edge of the screen and into each side and end of the frame. This strip not only protects the edge of the screen but also acts as a shoe for the tray, making it slip readily on the supports nailed to the side of the drying compartment. To strengthen the tray, small strips of iron may be nailed across each corner. The lumber used for trays should be light and well seasoned.

A tray constructed as outlined contains approximately 18.6 square feet of drying area. With 17 trays in each compartment and 6 compartments in the drying house, there are about 1,900 square feet of drying area in a building like that in figure 6. Each square foot of drying surface accommodates about half a pound of fresh leaf drug or 1 pound of fresh root drug.

MANAGEMENT.

The regulation of a drier is chiefly a matter of control of the heat and the flow of air. In using the hot-air furnace both heat and flow of air are controlled as one, since the flow of air is increased or decreased with the raising or lowering of the temperature. The rate of heating necessary to dry any particular drug is learned only through experience. A broad general rule, however, is to use extremely low heat on drugs in which the value depends upon a volatile constituent, a very moderate heat on ordinary leaf and herb drugs, and a moderate heat on root and bark drugs. Never employ the highest temperature at the beginning of drying, but start with a low temperature and gradually increase up to the desired degree. At no time is it desirable to employ a high temperature.

CARE OF DRIED CRUDE DRUGS.

After the crude drugs are dried they should be marketed as soon as convenient. It rarely pays to hold drugs in storage for any extended length of time.

A very convenient method for packing the dry drug materials is to bale them in an ordinary paper-baling machine. The bales should be wrapped in burlap and stored in a moderately cool, dark place. When the drug is first removed from the drying house it should be allowed to remain for several days before baling on a clean floor or in any clean bin protected from the light. During this period it will take up moisture from the atmosphere and become less brittle and easier to handle. Crude drugs can be packed in burlap sacks, in boxes, or in barrels. Paper cartons are often used to hold the baled drug. The bale neatly wrapped in burlap is the cheapest and most practicable form of preparation for shipment.

FARMERS' BULLETIN 1232
United States Department of Agriculture

SEED MARKETING HINTS *for the* FARMER

Contribution from the Bureau of Markets
GEORGE LIVINGSTON, Chief
Washington, D. C. Issued October, 1921

SEED MARKETING HINTS FOR THE FARMER.

GEORGE C. EDLER,
Specialist in Marketing Seeds.

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THE IMPORTANCE OF SEEDS.

SEEDS ARE PERHAPS of more importance to the agriculture of this country than anything else the farmer handles. Nevertheless no subject on agriculture of such relative importance has been so neglected as that of seed marketing. The farmer is virtually interested in this subject because in the cycle around which seeds go from the time they are harvested until they are planted, he is both seller and buyer, or, in other words, producer and ultimate consumer.

It has been estimated that more than 14,000,000,000 pounds of seeds, exclusive of seed potatoes, seed sugar canes, and other vegetative planting stocks are sown or planted annually in this country. Even a small improvement in the quality of seeds planted would result in larger crops at little or no additional expense or in the same production on a smaller acreage. Although soil and climatic conditions beyond the farmer's control determine to a large extent the quality of seeds, a small improvement can be accomplished by means that are more or less under his control. Better thrashing and hulling, recleaning, etc., which will tend to improve the quality of seeds, will be discussed later. Better marketing methods make the seed crop more profitable and tend to recruit the ranks of the comparatively small number of farmers who make a specialty of growing field seeds. Ordinarily the specialist, whether he be a doctor who confines himself to nervous diseases, a lawyer who confines himself to certain kinds of cases in civil law, or a farmer who each year sets aside an acreage for seed production and regards his seed crop as more than a mere side issue, is more skilled in his own particular undertaking than is the one whose interests and work are numerous and diverse. It would not be advisable for too many farmers to engage in seed production, because the supply of seeds of most agricultural crops is usually equal to or slightly in excess of the demand. Many farmers who are raising seeds could produce something else more profitably, and much seed is produced that should never be sown, but is used.

This bulletin is intended primarily to assist the mass of farmers in using better seed-selling and purchasing methods rather than to be of specific help to those farmers who specialize in seed production. To the latter, however, the general principles to be described will be quite as applicable as to the rank and file of farmers.

The question has often been asked: "Why is it that every farmer does not raise and plant his own seeds and thereby save for himself the profit others usually derive in selling him seeds?" Briefly, some of the reasons are as follows: (1) His fields may be foul with noxious weeds; (2) soil, climatic, and other conditions on his farm may be unfavorable for seed production in a given year; (3) altitude, latitude, or rainfall in his locality may preclude the production of a particular kind of seed in any year; (4) he may be able to buy better seeds at a lower cost than can be produced in his locality; (5) he may find it more profitable to grow a crop for hay or forage purposes than for seed production; (6) he may not have the facilities for harvesting, cleaning, curing, or otherwise preparing his seed for planting purposes; (7) he may need seed of a crop that has not been grown by him for several years, if ever at all; and (8) he may have to replant his fields either with the same kind of seed, his supply of which may have been exhausted with the first planting, or with seed of some catch crop.

In general, farmers obtain their seed from three sources, namely, from their own farms, from other farmers, or from dealers. The percentage that is obtained from each of these three sources varies considerably with the kind of seed under question and the locality where the seed is planted. The Bureau of Markets of the Department of Agriculture made an extensive survey in this connection and published detailed figures relative to it in the Seed Reporter for July and October, 1919. The following table gives percentages of each of five important classes of seeds that indicate the relative importance of the sources from which farmers in various geographical divisions obtain these seeds.

TABLE 1.—*Normal sources of seed supply.*

Group of States.	Grasses.			Clovers and alfalfa.			Millets.			Forage sorghums.			Small grains.		
	From own farm.	From other farms.	From dealers.	From own farm.	From other farms.	From dealers.	From own farm.	From other farms.	From dealers.	From own farm.	From other farms.	From dealers.	From own farm.	From other farms.	From dealers.
	P.ct.	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.c'.*
Eastern	5	2	93	6	3	91	3	1	96	1	0	99	44	12	44
Southern	6	4	90	11	5	84	12	6	82	36	13	51	45	15	40
Central	23	12	65	30	18	52	20	11	69	25	12	63	76	15	9
Northern	69	13	18	18	16	66	13	10	77	5	5	90	78	14	8
Far Western	4	2	94	12	9	79	7	3	90	16	18	66	59	15	26

PREPARATION OF SEED FOR MARKET.

THRASHING.

In view of the fact that there generally is a better demand and, of course, a higher price, for seed of fancy quality than for seed of inferior quality, it behooves the farmer to do whatever he can to improve the quality. Some of the factors commonly considered in determining the quality of seed are color, size, plumpness, and purity. Although climatic conditions at and subsequent to harvest time not under the control of the farmer may affect the quality of the seed, other factors, such as manner of thrashing and cleaning, that are more or less under his control may have even a greater effect upon quality. Except in regions where the production of a given kind of seed is large and special thrashing or hulling machines are available, the farmer usually has to rely on the common thrashing machine, possibly with some special attachments, for thrashing his seed.

Clover and grass seeds are generally considered more difficult to thrash than grain. The proper adjustment of concaves and air-control, and the selection of screens or sieves vary considerably with the kind and condition of the seed to be thrashed. In thrashing clover seed, the concaves should be so adjusted that all of the seeds are removed from the hulls, whereas in the case of timothy care should be exercised to prevent as much as possible the removal of the thin, papery-like hulls from the kernels, because timothy seed without the hulls normally sells at a lower price than seed with the hulls. In thrashing sorghums, broom-corn millet, and many other kinds of seeds the concaves should be as far from the cylinder as possible without allowing too much of the seed to pass unthrashed into the straw pile, otherwise many of the seeds may be cracked or broken, and subsequent thorough recleaning made impossible or expensive. Special seed recleaning attachments on thrashing machines are highly desirable and are not expensive and the farmer should endeavor to have them used. Sieves of the right size intended for small-seed cleaning purposes and adjusted properly, and careful regulation of the air-blast increase the effectiveness of the work done by the common thrashing machine where special machines are not available.

CLEANING.

About 75 per cent of the farmers who make a practice of producing seed in surplus quantities whenever climatic conditions are favorable clean the seed before selling it. A much smaller percentage of the farmers who seldom produce surplus quantities clean their seed. The cleaning, if any, that the average farmer gives his seed merely removes dirt, chaff, and weed and other foreign seeds that are much larger or smaller or much heavier or lighter than the kind of seed that is being cleaned. Such seed must be recleaned by the seedsman before being offered for sale. Although it would be impracticable for a farmer to

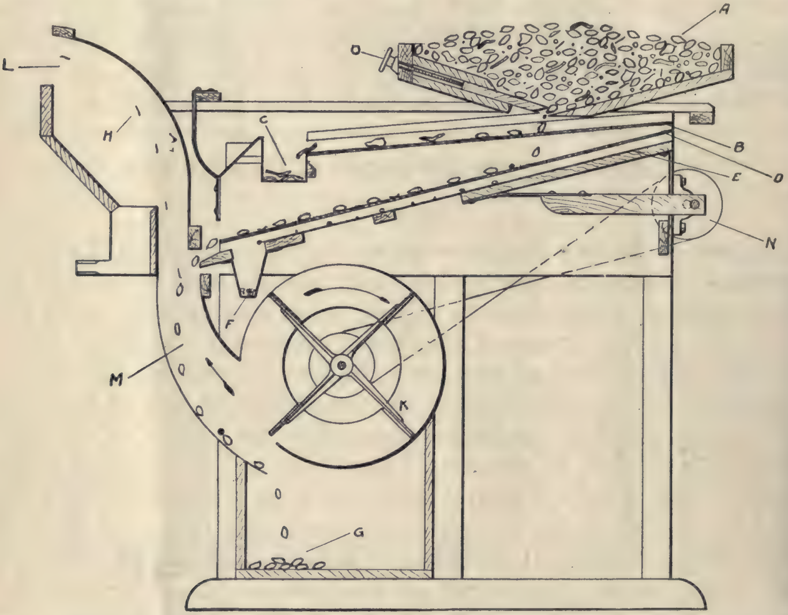

FIG. 1.—Seed-cleaning machine: A, Hopper filled with country-run timothy seed; B, coarse screen which is agitated back and forth longitudinally; C, straw-spout for carrying off straw, sticks, large weed seeds, etc., which are too long, wide, or thick to pass through coarse screen B; D, fine screen which is agitated back and forth longitudinally; E, pan onto which small weed and other small foreign seeds, sand, and other fine particles fall after passing through fine screen D; F, screenings-spout for carrying off fine material that falls on pan E; G, timothy seed which after passing over fine screen D drops to floor or box under fan K; H, dust, chaff, and light shriveled seeds that are blown out through dust hood L by the draft of air from fan K; K, fan for separating chaff and light foreign seeds from timothy seeds as they drop from fine screen D to air shaft M; L, dust or chaff hood; M, air shaft; N, eccentric for giving end or longitudinal shake to the two screens, thereby aiding in the cleaning of the seed; O, adjustment for regulating the flow of seed from the hopper.

maintain a battery of cleaning machines as many seedsmen do, it would seem advisable for more farmers in the grass and clover seed producing sections to own either individually or jointly a seed-cleaning mill. An efficient one can be bought for $40 to $50, including a set of screens. Figure 1 illustrates a type of mill that is simple and well adapted for cleaning grass and clover seeds; it may also be used for cleaning corn, wheat, oats, etc., by means of different combinations of screens and changes in the adjustment of the air-control.

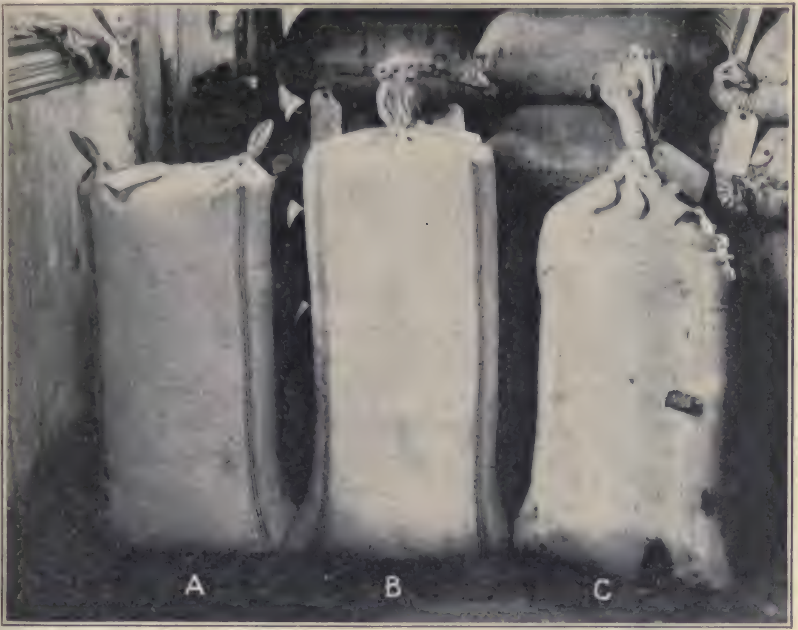

FIG. 2.—Properly and improperly tied bags.

SACKING.

The attractiveness of the package or container adds much to the salability of an article. The progressive seedsman realizes this and generally uses new, 16-ounce, 2-bushel cotton bags of some standard make for grass, clover, and vegetable seeds. The top of the bag should be sewed instead of tied. Unless the sewing is done by machinery a curved bag-sewing needle costing 5 or 10 cents is used. Whenever second-hand bags are used considerable care is exercised in patching or sewing up all holes, and if the bag is tied, it usually is done in two places. Seed is too frequently shipped in damaged bags, the larger holes being stopped up by corn cobs, sticks, wads of paper, etc., or the cloth around the hole gathered up and tied. A hand-sewed (A) and a properly tied bag (B), together with one that is tied improperly (C), are illustrated in figure 2.

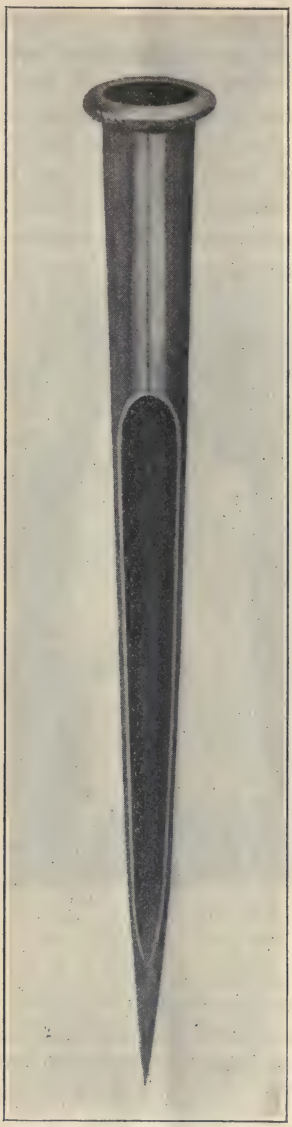

FIG. 3.—Seed trier or sampler.

A 5 or 6-inch trier costs about $1.50, and if carefully used will not injure a cotton bag. The trier is inserted its full length into the bag with the large open end of the trier inclined downward so that the seed will run out of the trier. When enough seed has been obtained for a sample the trier is pulled out and the small opening in the bag is closed easily by drawing the point of the trier lightly across the opening a few times.

SAMPLING.

In obtaining samples of seed offered for sale or for which a purity or germination test is desired, an inexpensive handy device, known as a seed trier or sampler and illustrated in figure 3, facilitates the work considerably. A sample should represent accurately the bulk of the seed from which it is taken. During shipment, or even after standing for any length of time, the smaller and heavier seeds show a tendency to work downward in the bag, bin, or other container. Therefore, in drawing a representative sample from a bag it is advisable to insert the trier in the top, middle, and bottom of each bag or in multiples of 5 or 10 bags, if the lot is a large one. The successive samples that have been drawn should be mixed thoroughly so that a smaller composite sample may be obtained therefrom which will represent accurately the bulk of the seed sampled.

TESTING.

The farmer should test his seed, or have it tested, for purity and germination whether it is offered for sale or used on his own farm. In making a purity test it is customary to determine the percentage of (1) pure seed, (2) inert matter such as dirt, chaff, and broken seeds, and (3) foreign seeds, including weed and other seeds. A sample varying in weight from 1 to 100 grams or more (a teaspoonful for the clovers and small-seeded grasses, a tablespoonful for the grass seeds, and a considerably larger amount for cereal grains), depending upon the size of the seed being examined, is usually taken. In making a germination or viability test to determine the percentage of seeds that will grow, usually two lots of

100 seeds each are placed on or between blotting paper, Canton flannel, etc., and kept in a room or chamber at a temperature of 60° to 80° F. for 3 to 28 days, depending upon the kind of seed being tested.[1]

Samples for purity and germination tests may be sent to the Seed Laboratory of the Department of Agriculture at Washington, D. C., or to the nearest Branch Seed Laboratory located at the following points, Lafayette, Indiana; Columbia, Missouri; College Station, Texas; Corvallis, Oregon; and Sacramento, California.

TAGGING.

Every lot of seed should be tagged or labeled immediately after thrashing to distinguish it from other lots of a different variety, strain, quality, etc. Space should be provided on one side of the tag for recording the purity and germination tests, and such other information as is necessary or desirable, and on the other side for the name and address lines of buyer and of grower. Some States require only a statement of the kind and purity of the seed, together with the name and address of the vender. If the grower is certain that he will not offer his seed for sale outside his own State, it is not necessary for him to provide space for more information than is required in that State. Information regarding the requirements of the various States may be obtained upon application to the State Experiment Station or State Board of Agriculture. In order, however, to make the tag as adaptable as possible for use in all States without increasing the cost materially, space should be provided for stating the percentages of pure seed, inert matter, and foreign seed; names and number or percentage of noxious weed seed; germination percentage, date of germination test; State or county where seed was grown, and the year when grown. A suggested form of tag which would comply with the tagging or labeling requirements of practically every one of the 38 State seed laws[2] is illustrated in figure 4.

STORING.

Some seeds such as corn and certain vegetable seeds usually must be cured or dried, either naturally or artificially, before they may be stored safely. In general any kind of seed that contains a high percentage of moisture when harvested will mold and deteriorate in germination if allowed to remain undisturbed in a deep pile without free access of air. The stage of maturity of the seed when harvested, moisture content when stored, and ventilation of the building where stored must be carefully considered preparatory to storing seed. Many farmers find it profitable to place their seed corn on racks or suspend it on wire hangers so that the ears do not touch one another, and further to facilitate drying by means of stoves, fans, or air ducts. The interior of a farmer's seed corn drying house is shown in figure 5.

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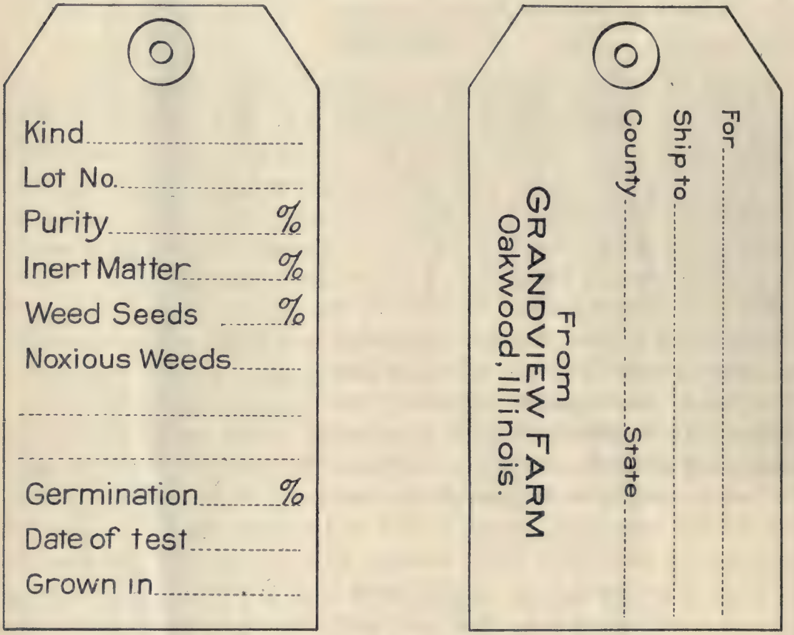
[1] The manner of conducting these tests is explained fully in U. S. Department of Agriculture, Farmers' Bulletin No. 428; Testing Farm Seeds in the Home and in the Rural School, by F. H. Hillman. 1911.

[2] Up to September, 1921, the following States had seed laws: Ariz., Calif., Colo., Del., Idaho, Ill., Ind., Iowa, Ky., La., Me., Md., Mich., Minn., Mo., Mont., Nebr., N. H., N. J., N. Mex., N. Y., N. C., N. Dak., Ohio, Okla., Oreg., Pa., S. C., S. Dak., Tenn., Tex., Utah, Vt., Va., Wash., W. Va., Wis., and Wyo.



Kind..................

Lot No..................

Purity.................. %

Inert Matter.................. %

Weed Seeds .... %

Noxious Weeds..........

....

....

Germination.................. %

Date of test..................

Grown in..................

For..................................

Ship to..................................

County.................. State..................

From

GRANDVIEW FARM

Oakwood, Illinois.

FIG. 4.—Seed tags (front and back), two-thirds natural size.

Unless a farmer wishes to engage extensively in the business of seed production, it probably would not pay him to erect a special seed house. Usually there are one or more buildings on the farm which are suitable for storing seed. A dry, well-ventilated place such as a granary should be chosen and the seed, if in bulk, should not be piled too deep. In most cases it probably is advisable to store seed in bags piled neatly with the lowermost layer raised off the floor by strips of wood. Precautionary measures should be taken against rodents, and if many weevil or other insects are working in the seed it may be advisable to fumigate with carbon disulphid.[3]

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[3] See U. S. Department of Agriculture, Farmers' Bulletin No. 799; Carbon Disulphid as an Insecticide, by W. E. Hinds. 1917.

SELLING SEEDS.

WHERE TO SELL.

The farmer who has produced a surplus of seed may sell it to any one of the following: (1) His neighbors, (2) other farmers through advertising, correspondence, etc., (3) local shippers, (4) traveling seed buyers, (5) distant seedsmen by mail, and (6) by advance growing contract. In reply to questionnaires sent out by the Bureau of Markets 2,400 growers scattered throughout the United States submitted data which are summarized in Table 2.

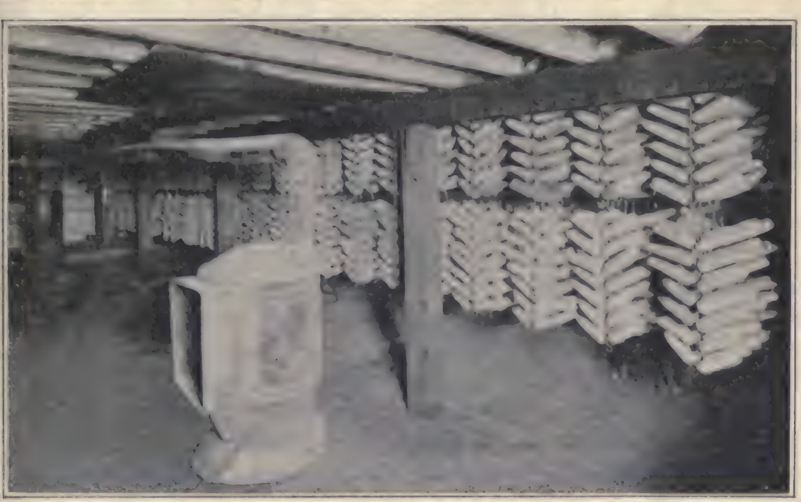


FIG. 5.—Interior of seed-corn drying house.

TABLE 2.—*Percentage of growers using various agencies in selling seeds.*

Agency.	Clovers.	Grasses.	Millets.	Sorghums	Peas and beans.	Potatoes.	Seed grains.	Seed corn.	Cotton seed.
	P.ct.	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*
Neighbors	38	41	38	39	40	42	46	45	39
Other farmers	13	8	12	16	14	15	17	23	25
Local shippers	24	25	30	27	22	24	21	16	20
Traveling seed buyers	8	8	2	5	3	7	3	2	2
Distant seedsmen	15	17	18	11	15	9	10	11	12
Advance growing contract	2	1	0	2	6	3	3	3	2

From the figures in Table 2 it is apparent that the farmer sells more of his seed to neighbors, but that he also sells considerable to the local shipper. Distant seedsmen by means of their traveling buyers and correspondence buy large quantities of seed direct from farmers. Although probably most of the vegetable seeds are produced on advance growing contracts entered into between large commercial vegetable-seed growers and farmers located in more or less well-defined areas, only a small percentage of field seeds are disposed of by farmers in this way.

Which of these agencies can be used most profitably by the farmer in selling his seed is largely a local problem and varies somewhat from year to year. If one farmer alone in a neighborhood has produced a certain kind of seed in a given year, he probably will find it most advantageous to sell it to his neighbors or to a local dealer for resale in the community. On the other hand, if a considerable number of farmers in a locality have produced seed, and are not in the habit of doing so, they will have to look outside their immediate vicinity for an outlet and may find it feasible to pool their seed and sell it through their farm bureau, county agent, State marketing agent, or through the various channels used in other localities. In sections that usually produce a large surplus of certain kinds of seed, there frequently are two or more local shippers, who may or may not be acting as buying agents for a like number of seedsmen. The competition between them often results in the paying of higher prices than elsewhere. If the farmer believes that there is no actual competition between his local shippers, and that they are not paying as much as the seed is worth, it is advisable for him to submit samples, drawn in a manner already explained, to several seedsmen, including two or more who are not being represented by the local shippers, and to request bids on these samples. If a group of farmers has a carload or more of seed for sale they frequently can induce a distant seedsman to send a buyer to see the seed. Such a buyer is usually a good judge of seed values and is in a position to pay maximum prices for the quality offered.

Some farmers obtain good results from advertising in near-by county newspapers and in agricultural periodicals which circulate in sections of the country that consume relatively large quantities of the kind of seed offered for sale.

Various Federal and State publications and, within recent months, county newspapers and agricultural periodicals publish current information relative to the supply, demand, movement, and prices of the important kinds of field seeds, when the principal movement of each kind from the farm is taking place. The farmer who makes use of this information has a better understanding of the worth of his seed and can cope with the dealer on more even terms than in the past, when the dealer was almost alone in his knowledge of what was going on in the seed markets.

WHEN TO SELL.

There is no one best time at which to dispose of seeds. The general rule of selling when the buyer is anxious to buy holds as true in seed transactions as in others. Ordinarily seedsmen are eager to buy seed as soon after thrashing as possible, especially if the carryover of that particular seed from previous years is less than normal; furthermore, there frequently is a good early demand for certain kinds that are sown in the fall as well as in the spring. Most large seedsmen buy the bulk of their grass and clover seed before February 1 and make purchases after that date to fill open orders or to replenish low stocks. Frequently higher prices may be received after February 1, but the grower runs considerable risk in not being able to dispose of his seed to seedsmen as late as that, and consequently of being compelled to carry it over until the next planting season or to sell it to some seedsman, who is willing to speculate on it, at a price usually considerably below current prices.

By keeping in touch with the published seed market information for the entire country and not focusing all of his attention on local conditions, which may be just the opposite from those prevailing elsewhere, the farmer can determine pretty well for himself when it is advisable to sell his seed.

HOW TO SELL.

It is customary for local shippers and seedsmen to pay cash for seed. The seed shipped should be equal in quality, and preferably identical, to the sample on which the sale has been based. If the seed, upon arrival at the seedsman's warehouse proves to be of decidedly inferior quality, it may be refused or discounted by the seedsman, especially if the market declines after the transaction. Therefore to minimize claims and to foster good business relationship between seller and buyer, extreme care in sampling should be taken and the seller and buyer should each retain samples, properly identified, for future reference in case of disputes.

The seed should be bagged and tagged properly, as already explained. If possible, the farmer should sell his seed f. o. b. (free on board), his station, so that any subsequent increases in freight rates, losses in weight, or damage to seed during shipment must be assumed by the buyer.

Most farmers prefer to sell their seed "as it stands," or "in the dirt" without having any dockage assessed, because it is easier for them to calculate what their returns will be and disputes over the amount of dockage are not so apt to arise. The seed buyer, however, in making his bid, takes into account either by actual test or by guess, which may be close or far off, dependent upon his training and experience, the amount of dockage (dirt, straw, weed and other foreign seeds), contained in the seed. Ordinarily the buyer pays little or nothing for the dockage, but deducts it from the weight of the seed. Instances have been recorded where the dockage was actually worth more than the pure seed purchased—for example, white clover seed screened from country-run redtop seed in the fall of 1916. If the dealer should offer a farmer $15 per 100 pounds less 10 per cent dockage for a lot of red clover seed weighing (without the bags) 1,000 pounds, the total amount received by the farmer would be 1,000 pounds—100 pounds (10% of 1,000)=900 pounds at $15 per 100 pounds=$135. This offer on the lot would be $5 better than an offer of $13 per 100 pounds "as it stands" or "in the dirt" without dockage. The best way out of disputes arising over dockage is to clean the seed and not pay the freight, either directly or indirectly, on the screenings it contains. A further advantage accruing from cleaning seed over a good fanning mill is that the clean seed instantly presents a far better appearance to the buyer than trashy and weedy seed does and the buyer either consciously or unconsciously is influenced to pay more for it.

BUYING SEEDS.

GENERAL SOURCES.

There are more consumers than producers of seed. Many farmers produce enough seed to supply the needs of hundreds of other farmers. The average farmer, therefore, is more interested in knowing where to buy seed than in knowing where to sell it. The first source of supply to which he commonly looks is his neighbor or local dealer. He is more or less familiar with the character of the weeds on his neighbor's farm and usually prefers to plant home-grown seed. He knows the local dealer and feels that adjustments can be made if the seed is not satisfactory. Frequently, however, the farmer can obtain better seed at a lower cost from growers or shippers in surplus producing areas or from distant seedsmen.

In general, a heavy producing area of a particular kind of farm seed is also a heavy consuming area of that seed, and in most cases is the area in which relatively greater quantities are used than elsewhere. Many seedsmen fail to consider this fact and judge the total consumption of seed in various sections by their own sales of seed in those sections.

SURPLUS PRODUCING AREAS.

SEED GRAINS.

Normally, surplus quantities of seed grains, such as wheat, oats, barley, rye, speltz, etc., are produced in localities that are well adapted to their culture. The Northwestern, Central, Southwestern, and North Pacific States contain localities that are usually able to make up the seed grain shortages in other localities within the same geographical divisions or elsewhere. This class of seed usually is not shipped so far from the region of production as grass and clover seed are because: (a) The soil and climatic conditions under which seed grains are grown are believed to have a marked effect upon the adaptability of such seed to withstand different growing conditions elsewhere, (b) seed grains are more bulky and a larger quantity of seed per acre is required than in the case of grass and clover seed, and (c) seed grains are easier for the average farmer to clean or have cleaned than grass and clover seed.

CLOVERS AND ALFALFA.

Grass and clover seed are produced in surplus quantities, for the most part, in the Central States and in a few of the States west of the Rocky Mountains. Because hay or green forage in the East is worth more than seed to farmers in that section and climatic and other conditions are not so favorable for profitable seed production as in Central and Western States, comparatively few counties in the Eastern States produce surplus quantities of grass and clover seed, except during occasional years when weather conditions are unusually favorable for seed production, seed prices are high, and forage is abundant.

In figure 6 the solid black dots indicate where surplus quantities of red clover seed normally are produced. The surplus producing areas of alsike clover seed coincide in general with those for red clover seed, except that they do not extend so far south in Indiana and Ohio, and include western New York.

White clover seed is produced in surplus quantities in only a few regions, though it is sown in almost every section of the United States. The main regions of production are in southeastern Wisconsin and southern Idaho. Some years considerable white clover seed is produced in the redtop section of southern Illinois and elsewhere. Its production is more or less sporadic and in a given year a surplus may be found in several States which ordinarily do not produce enough to satisfy their own requirements.

A surplus of crimson clover seed is normally produced in a few counties in southern Tennessee and Kentucky and in scattered localities in Delaware, Maryland, Virginia, North Carolina, South Carolina, and other Southern States. Until recent years, only a very small portion of the crimson-clover seed used in planting has been grown in this country, most of it being imported.

Sweet clover grows wild in many States, but the production of seed on an important scale is confined in general to areas that produce a surplus of alfalfa seed and also to isolated sections in North Dakota, Kentucky, Alabama, and Mississippi.

The use of alfalfa has been extended gradually until it is being grown in practically every State in the Union. The production of alfalfa seed, however, is confined to regions west of the Mississippi, where the precipitation at the time the crop sets seed is very light. Figure 7 indicates the regions of heaviest alfalfa seed production,

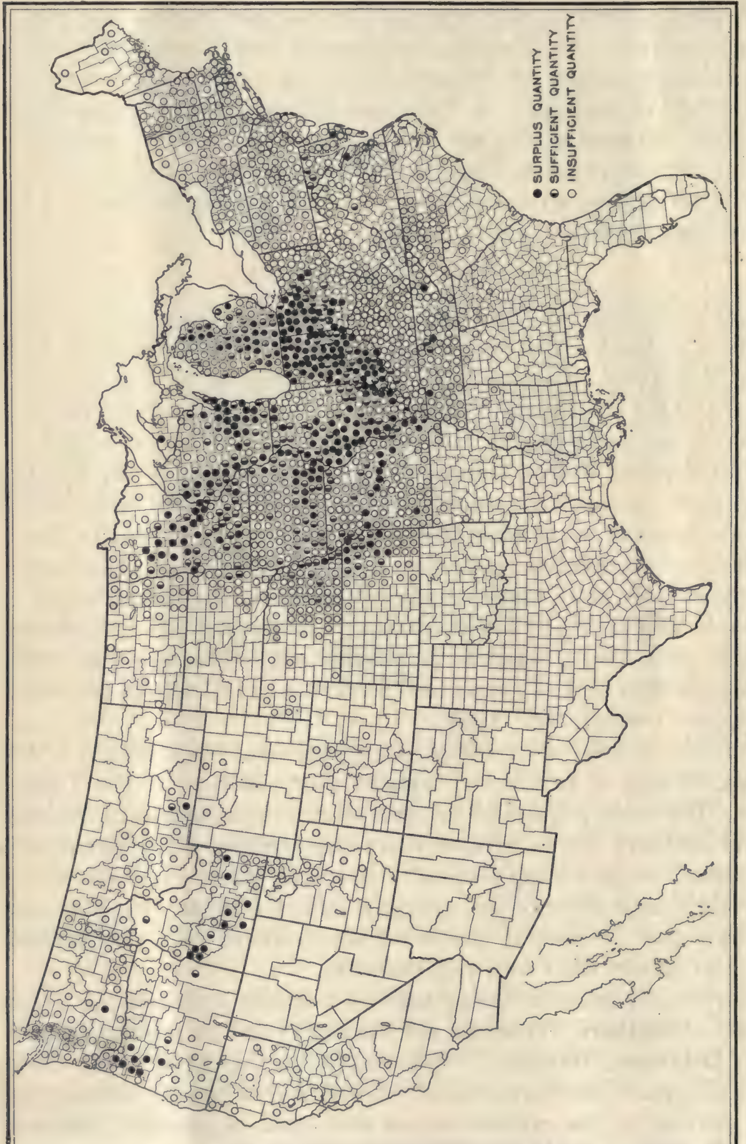


FIG. 6.—Red clover seed map.

Counties reported as normally producing either a surplus quantity, a sufficient quantity, or an insufficient quantity of seed compared with planting requirements.

together with other regions that normally depend upon seed from outside to take care of their sowing requirements.

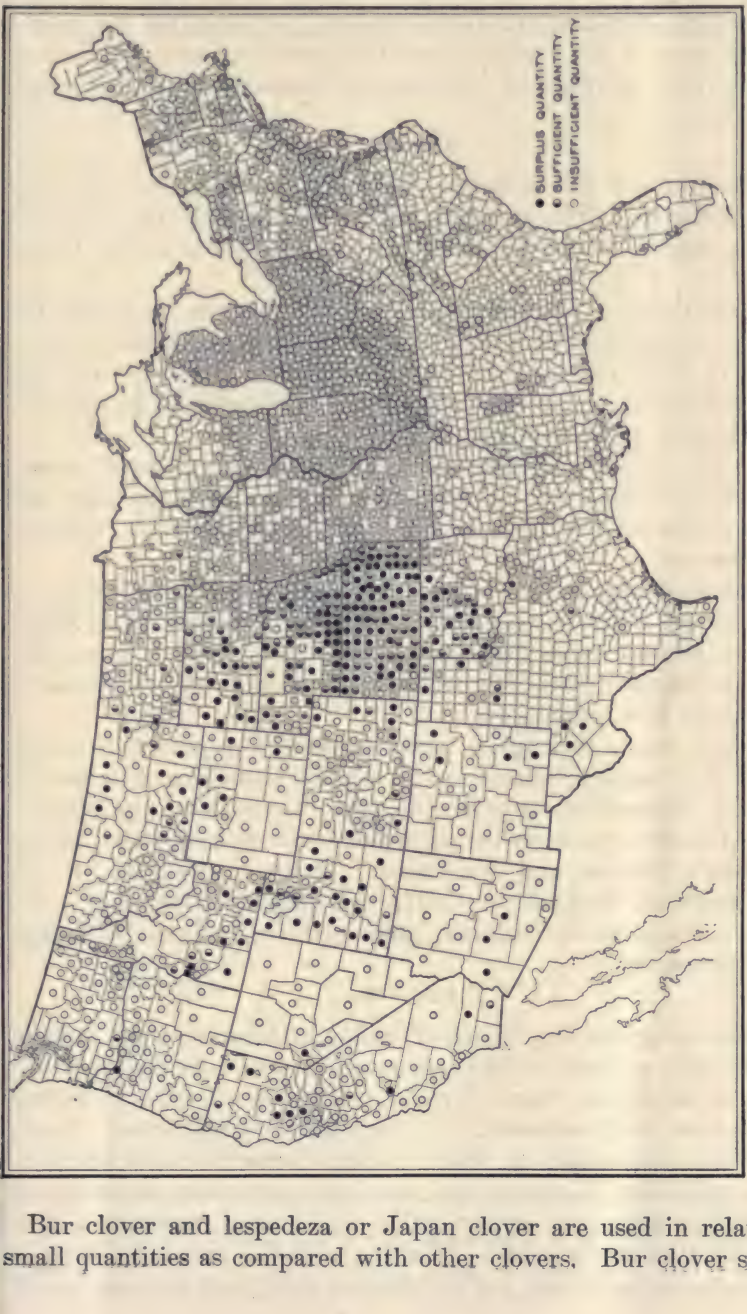


FIG. 7.—Alfalfa seed map.

Counties reported as normally producing either a surplus quantity, a sufficient quantity, or an insufficient quantity of seed compared with planting requirements.

Bur clover and lespedeza or Japan clover are used in relatively small quantities as compared with other clovers. Bur clover seed is produced in commercial quantities mainly in two widely separated areas, namely, California and several of the Southern States, including Alabama, North and South Carolina, Arkansas, Georgia, and Mississippi. Southeastern Louisiana and north-central Mississippi produce most of the lespedeza seed that enters commercial channels, but one or two counties in Alabama and Tennessee also usually have a surplus.

GRASSES.

The solid black dots in figure 8 indicate the regions normally producing a surplus of timothy seed. It will be noted that the sowing of timothy seed is confined to the northern two-thirds of the United States.

Practically all of the redtop seed that supplies the demand in this country, as well as in Europe, is produced in southern Illinois. Some redtop cleaned from timothy seed produced in southern Iowa and Minnesota finds its way into the market, but the quantity thus obtained usually is commercially unimportant.

Orchard grass is not very widely grown and the areas of surplus production are situated in a few counties of northern Kentucky and southern Indiana and in several isolated counties in Ohio, Virginia, and Missouri.

Kentucky bluegrass seed is the main constituent of most lawn grass seed mixtures in the northern half or two-thirds of the United States. Most of the seed comes from northern Kentucky, northwestern Missouri, and southwestern Iowa, where special machinery for harvesting the seed has been introduced.

Meadow fescue or English bluegrass seed is produced in surplus quantities in eastern Kansas and to a much lesser extent in western Missouri. Smooth brome grass (*Bromus inermis*) seed production is confined mostly to scattered areas in North and South Dakota, Minnesota, Idaho, Oregon, and Washington. Bermuda grass seed is produced mostly in Arizona and California, while Johnson grass seed is grown in a number of Southern States, principally Texas, Louisiana, and Mississippi.

MILLETS.

Millets are grown mostly east of the Rocky Mountains and in many sections they are used chiefly as a catch crop to take the place of a crop that has failed. For this reason the acreage of millet in a given section is subject to considerable variation from year to year. Figure 9 indicates the regions in which golden (formerly called German) millet normally is grown and also the particular sections that normally produce more golden millet seed than is necessary to meet their planting requirements. Common millet is grown in the same regions as golden millet, but the surplus producing counties appear to be somewhat more extensive, although the total annual production of common millet seed probably is not so large as that of golden millet. Siberian millet is grown somewhat north of the golden and common millet areas, and the surplus seed-producing areas of this variety are confined to the States west of the Mississippi River and east of the Rocky Mountains from Kansas northward to North Dakota,

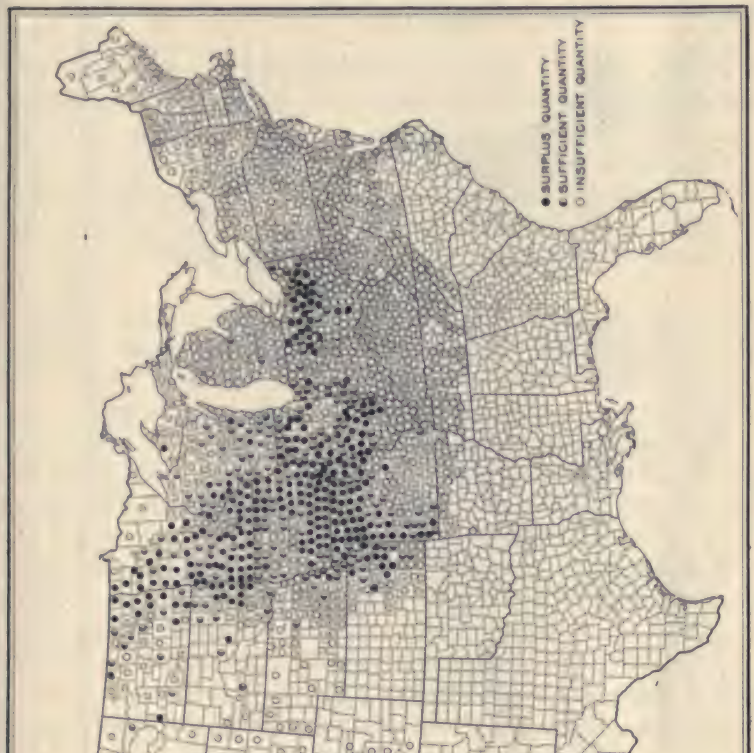


FIG. 8.—Timothy seed map.

Counties reported as normally producing either a surplus quantity, a sufficient quantity, or an insufficient quantity of seed compared with planting requirements.

also in scattered counties of Oklahoma, Texas, and New Mexico. Comparatively larger quantities of Japanese millet seed are used in the North Atlantic and East Central States than of Siberian millet seed. Commercial supplies are produced principally in Iowa, Nebraska, and New York, but occasionally counties in other States have a shipping surplus. Broom corn millet or hog millet seed is grown

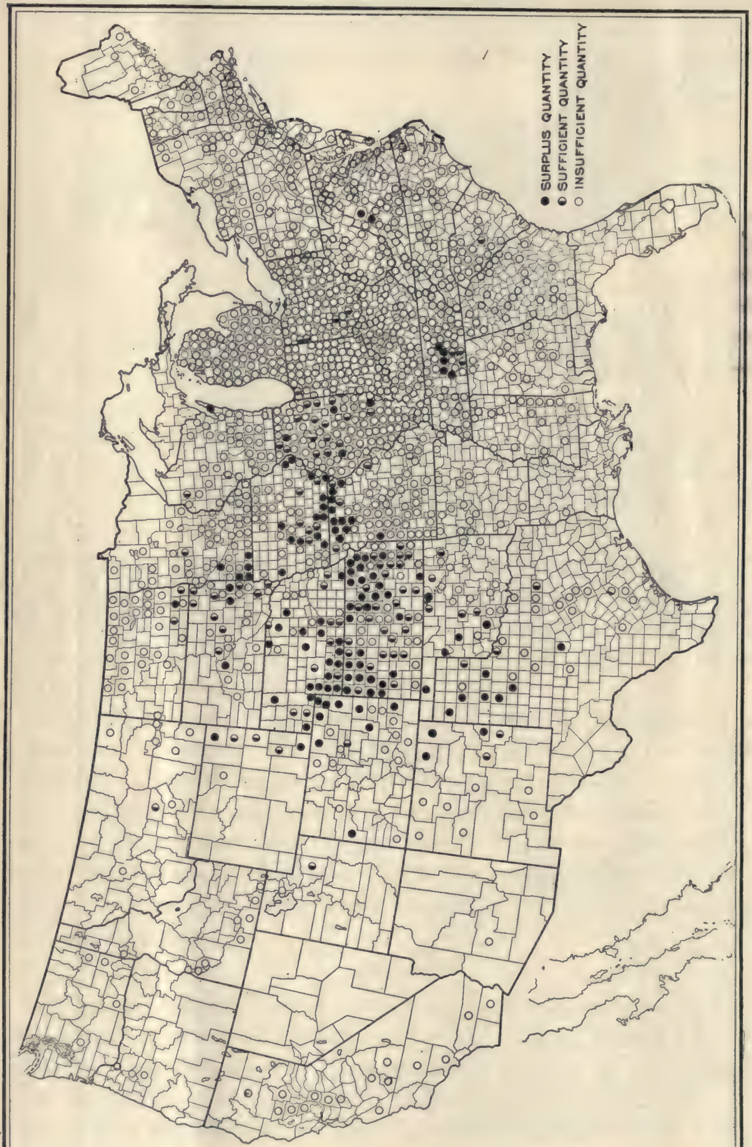


FIG. 9.—Golden millet seed map. Counties reported as normally producing either a surplus quantity, a sufficient quantity, or an insufficient quantity of seed compared with planting requirements.

more largely for feeding purposes than any of the other millets. Colorado, South Dakota, and North Dakota have been the leading States in the production of this variety of millet during the past few years.

SORGHUMS.

In some respects the marketing of grain sorghum seed is similar to that of small grains. In general grain sorghum seed is obtained in the same State in which the crop is to be planted. There are many kinds and varieties of grain sorghums, but only a few are of much commercial importance. Southwestern Kansas, western Oklahoma, and western Texas usually contribute most of the kafir and feterita used for planting purposes, and together with California, most of the milo.

Grain sorghum seed is used mostly for feed or food purposes, whereas forage sorghum or sorgo seed is used mostly for planting purposes. No attempt will be made to enumerate the many kinds and varieties of sorgos, or "cane" seeds commonly referred to by seedsmen. Figure 10 showing the surplus and consuming counties of amber sorgo seed will also afford the reader a good idea of the principal orange sorgo producing regions, as the two areas coincide for the most part. In the outlying northern localities of the forage-sorghum seed areas, more of the amber sorgo is used than of all the other kinds of sorgos combined; in fact, in Minnesota, Wisconsin, and South Dakota there is almost no demand for orange sorgo. Sumac or redtop sorgo is grown in many of the States that grow amber and orange sorgo, but not nearly so extensively. The surplus sumac sorgo seed producing area does not extend so far north as that of amber or orange sorgo.

Sudan grass, which belongs to the sorghum family, is being grown generally throughout the southern two-thirds of the country. The surplus seed producing counties are widely scattered except in portions of Texas, Oklahoma, Kansas, Colorado, and New Mexico, where they are rather consolidated, as shown in figure 11.

PEAS AND BEANS.

Canada field peas for seed purposes are grown principally in northern Michigan, Wisconsin, western Montana, south central Colorado, northern and southeastern Idaho, and northwestern and eastern Washington. In addition to these peas other kinds, such as marrowfats, Scotch, and Alaskas, are produced largely in the same sections.

Cowpea seed is produced chiefly in the Southern States, from Virginia to Texas, although some early varieties are grown in Indiana, Illinois, and Missouri. The crop is grown rather extensively for forage and grain purposes over the eastern half of the United States, as shown in figure 12.

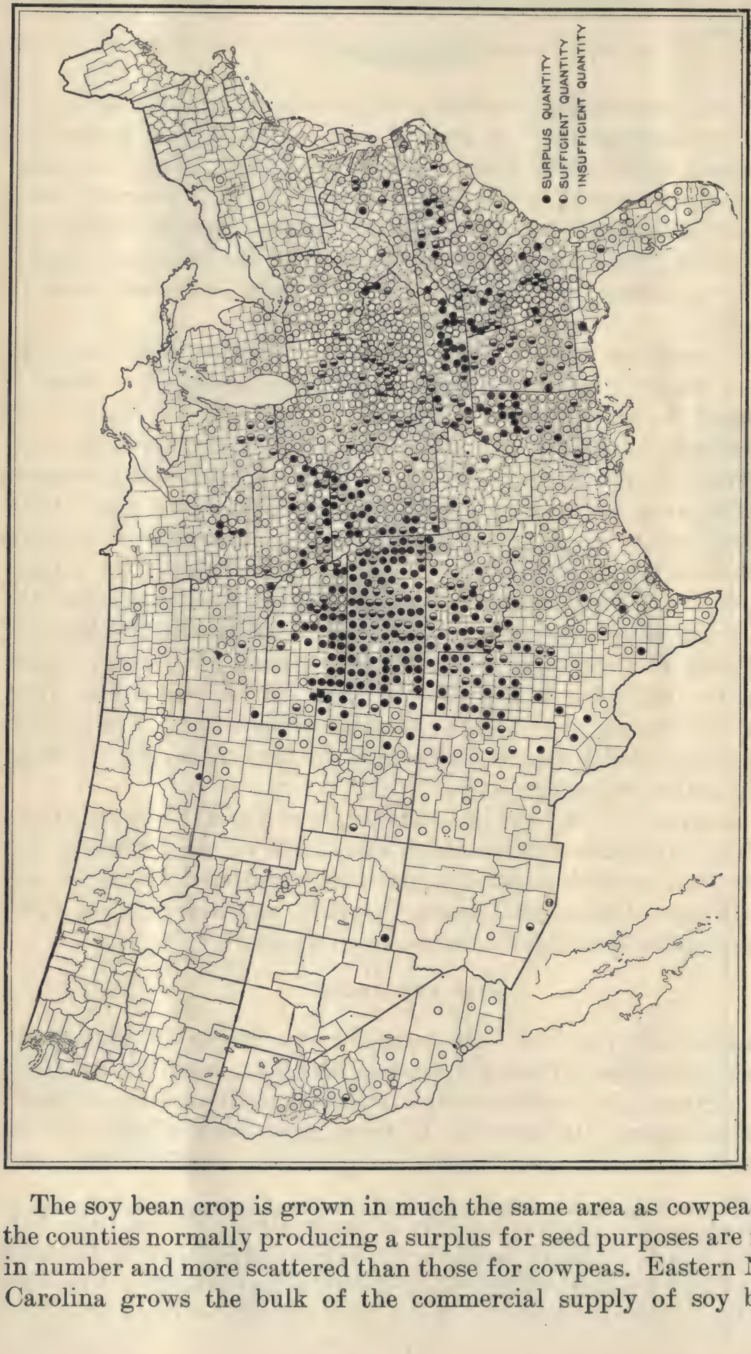


FIG. 10.—Amber sorgo seed map. Counties reported as normally producing either a surplus quantity, a sufficient quantity, or an insufficient quantity of seed compared with planting requirements.

The soy bean crop is grown in much the same area as cowpeas, but the counties normally producing a surplus for seed purposes are fewer in number and more scattered than those for cowpeas. Eastern North Carolina grows the bulk of the commercial supply of soy beans, which are mostly of the Mammoth Yellow variety. With the advent and wider distribution of earlier varieties of soy beans, this crop has

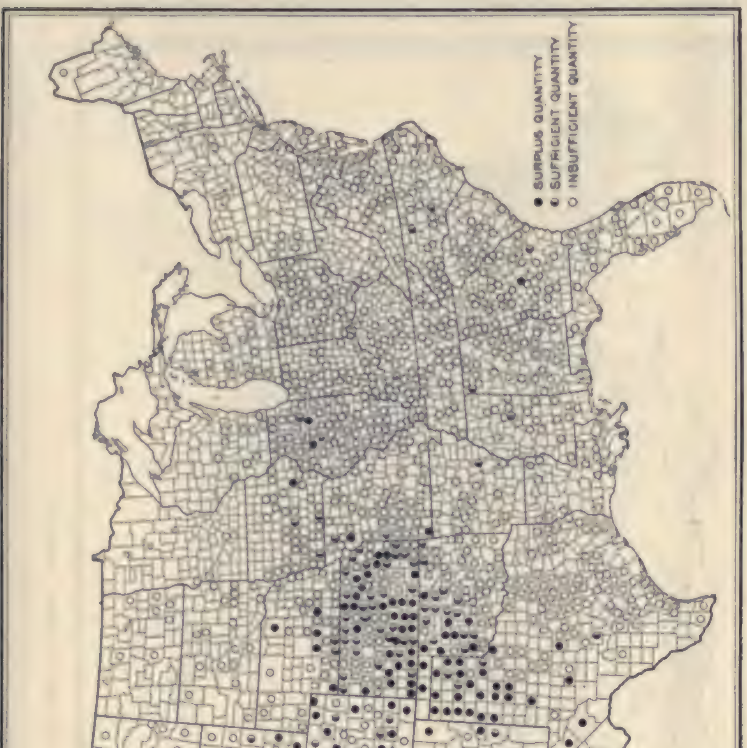


FIG. 11.—Sudan grass seed map.

Counties reported as normally producing either a surplus quantity, a sufficient quantity, or an insufficient quantity of seed compared with planting requirements.

become more popular in the North and surplus quantities are now being produced in a number of counties in Ohio, Indiana, Illinois, and Wisconsin, as indicated in figure 13.

SEEDSMEN.

Although large savings can at times be effected by buying seeds direct from growers and shippers in the surplus producing areas that have been mentioned above, many farmers prefer to purchase seed from mail-order seedsmen, who are usually located at important distributing points. Theoretically, timothy seed should be bought from

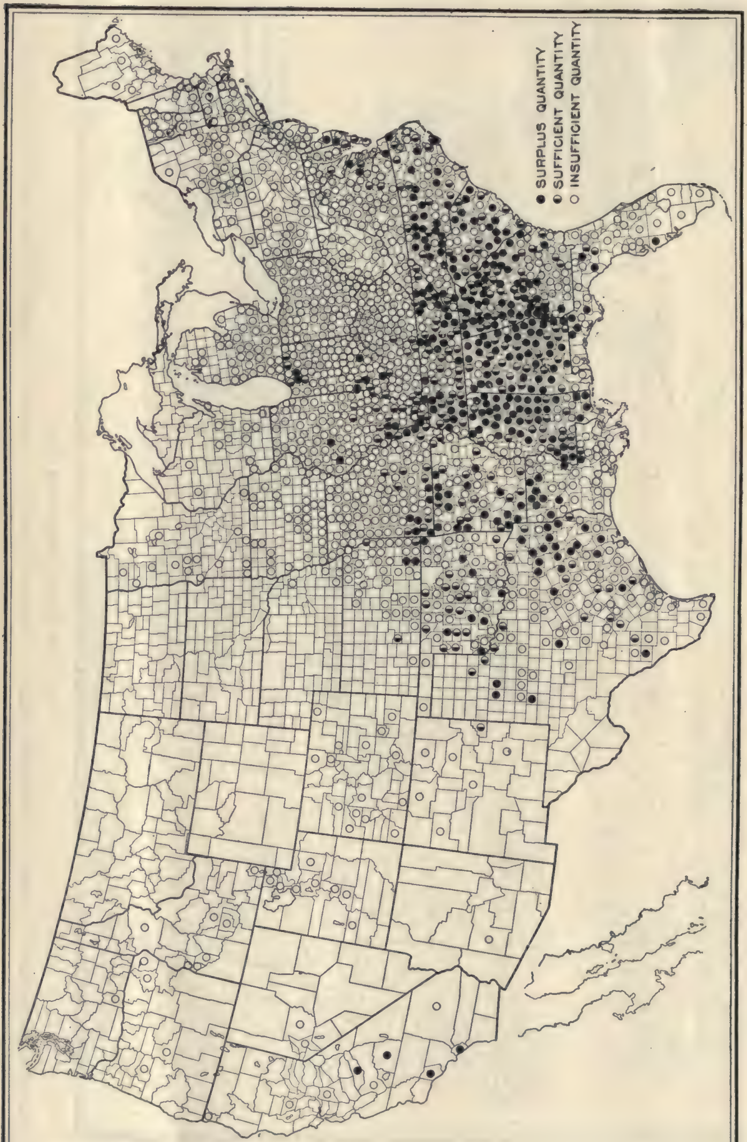


FIG. 12.—Cowpea seed map.

Counties reported as normally producing either a surplus quantity, a sufficient quantity, or an insufficient quantity of seed compared with planting requirements.

a seedsman in or adjacent to the timothy seed producing section; alfalfa seed from a seedsman in the alfalfa seed producing section; and Kentucky bluegrass seed from one in the Kentucky bluegrass seed

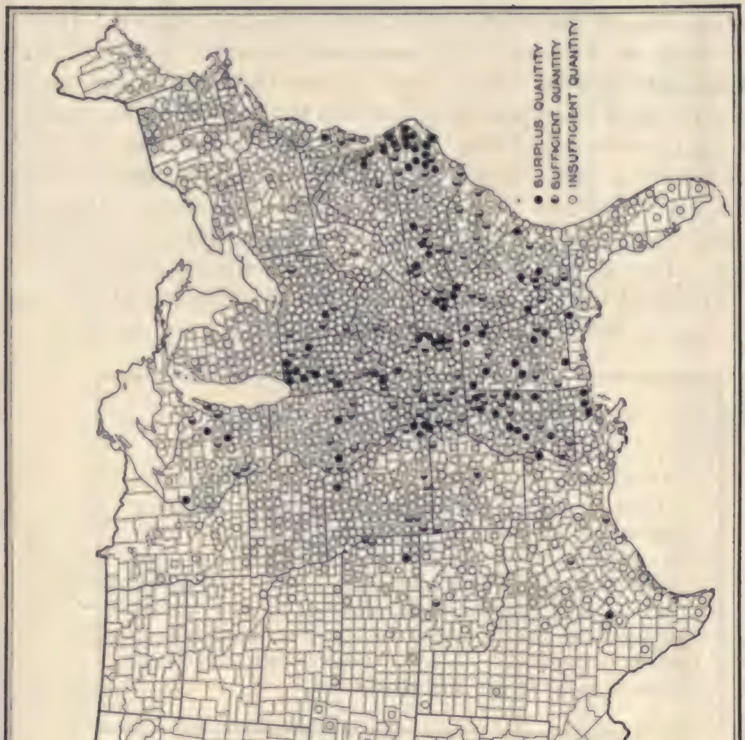
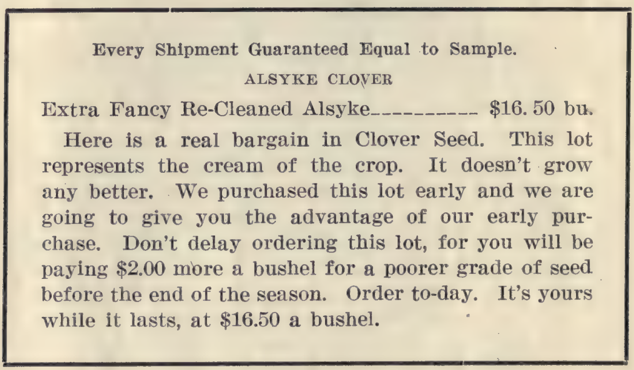


FIG. 13.—Soy bean seed map.

Counties reported as normally producing either a surplus quantity, a sufficient quantity, or an insufficient quantity of seed compared with planting requirements.

section. But in practice this usually would necessitate placing orders with a number of seedsmen and would not permit of any discount or better prices that might be obtained if the several orders were consolidated into one or two large orders. If a farmer does not have time or wish to go to the trouble of writing to several seedsmen for samples and prices, it often is practicable for him to buy from that seedsman who is most advantageously located with respect to the producing area of the main kind of seed which is wanted. It frequently happens, however, that seedsmen distantly removed from producing sections offer seed at lower prices than others, because of having made their purchases at opportune times and in large quantities, or being overstocked they may wish to close out some of their seed practically at cost. Hence it generally pays the farmer to " shop around a bit " if he has large purchases of seed to make. Although price is of importance, it should be secondary to quality, generally speaking. The farmer should not buy seed simply because it is cheap. It would be well for him to ask for samples and at the time of ordering to insist that the seed shipped be fully equal to or identical with the samples. He should test the seed or have it tested for purity and germination, as mentioned on pages 8 and 9. If there is any doubt regarding the business integrity of a certain seedsman, inquiries should be made locally, of the nearest experiment station, or of the United States Department of Agriculture for names and addresses of reliable seedsmen. Above all, he should not be misled by extravagant claims made by some seedsmen who are a discredit to the seed trade. An illustration of a claim which proved to be a gross misrepresentation is given in figure 14. The purity test (fig. 15) made by the department showed that the sample of " extra fancy recleaned " alsike clover under question purporting to be the " cream of the crop," contained only 54.76 per cent of pure seed, 2.99 per cent of inert matter, and 42.25 per cent of foreign seed. One-fourth of the sample was timothy seed, worth at the time only one-third as much as alsike clover seed. There was not



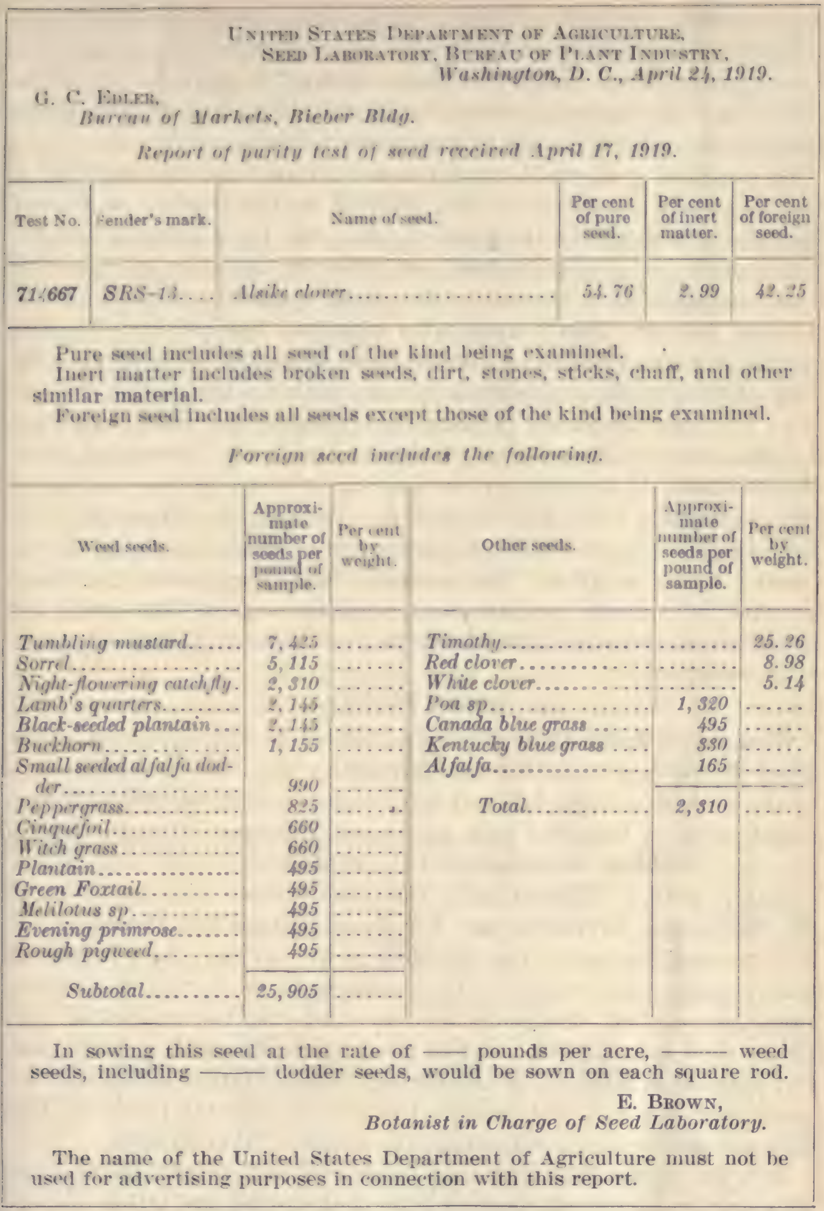
Every Shipment Guaranteed Equal to Sample.

ALSYKE CLOVER

Extra Fancy Re-Cleaned Alsyke---------- $16. 50 bu.

Here is a real bargain in Clover Seed. This lot represents the cream of the crop. It doesn't grow any better. We purchased this lot early and we are going to give you the advantage of our early purchase. Don't delay ordering this lot, for you will be paying $2.00 more a bushel for a poorer grade of seed before the end of the season. Order to-day. It's yours while it lasts, at $16.50 a bushel.

FIG. 14.—Alsike Clover Seed Ad.



UNITED STATES DEPARTMENT OF AGRICULTURE,
SEED LABORATORY, BUREAU OF PLANT INDUSTRY,
Washington, D. C., April 24, 1919.

G. C. EDLER,
Bureau of Markets, Bieber Bldg.

Report of purity test of seed received April 17, 1919.

Test No.	Sender's mark.	Name of seed.	Per cent of pure seed.	Per cent of inert matter.	Per cent of foreign seed.
71667	*SRS-13*....	*Alsike clover*.....................	*54.76*	*2.99*	*42.25*

Pure seed includes all seed of the kind being examined.

Inert matter includes broken seeds, dirt, stones, sticks, chaff, and other similar material.

Foreign seed includes all seeds except those of the kind being examined.

Foreign seed includes the following.

Weed seeds.	Approximate number of seeds per pound of sample.	Per cent by weight.	Other seeds.	Approximate number of seeds per pound of sample.	Per cent by weight.
Tumbling mustard......	*7,425*	....	*Timothy*...............	....	*25.26*
Sorrel................	*5,115*	....	*Red clover*............	....	*8.98*
Night-flowering catchfly.	*2,310*	....	*White clover*..........	....	*5.14*
Lamb's quarters.........	*2,145*	....	*Poa sp*...............	*1,320*	......
Black-seeded plantain...	*2,145*	....	*Canada blue grass*......	*495*	......
Buckhorn..............	*1,155*	....	*Kentucky blue grass*....	*330*	......
Small seeded alfalfa dodder..............	*990*	....	*Alfalfa*...............	*165*	......
Peppergrass............	*825*	....	*Total*............	*2,310*	......
Cinquefoil.............	*660*	....			
Witch grass............	*660*	....			
Plantain................	*495*	....			
Green Foxtail..........	*495*	....			
Melilotus sp...........	*495*	....			
Evening primrose.......	*495*	....			
Rough pigweed.........	*495*	....			
Subtotal..........	*25,905*	....			

In sowing this seed at the rate of —— pounds per acre, ——— weed seeds, including ——— dodder seeds, would be sown on each square rod.

E. BROWN,
Botanist in Charge of Seed Laboratory.

The name of the United States Department of Agriculture must not be used for advertising purposes in connection with this report.

FIG. 15.—Purity test of alsike clover seed sample.

sufficient space on the first page of the report reproduced in figure 15 to list all of the weed seeds found in the sample examined, and in addition to those listed there were 165 to 495 weed seeds per pound of sample of each of the following weeds: Small seeded false flax, dock, mouse-ear chickweed, yellow trefoil, worm-seed mustard, sleepy catchfly, nerved manna grass, *Panicum sp.*, and *Syntherisma sp.* The total number of weed seeds in a pound of this "bargain lot" of alsike clover seed was approximately 28,215, including some noxious kinds that would prohibit its sale in a number of States.

In purchasing vegetable seed, the most important consideration is the reliability of the seedsman. Except to the trucker or farmer engaged extensively in the growing of a crop for a canning factory, a few cents per pound or even per ounce in the price of vegetable seed is insignificant because of the small quantity required by the average farmer. The location of a seedsman has but little bearing on the area from which he obtains most vegetable seeds because the bulk of these seeds is produced in comparatively few rather well-defined sections, as shown in maps published in the Seed Reporter, (United States Department of Agriculture) for November, 1918. For example, if domestic-grown carrot or celery seed is purchased the chances are more than 10 to 1 that the seed was grown in California regardless of whether it comes from a seedsman in the North, South, East, or West. In vegetable seed the terms "northern grown," "dry-land," etc., are not so significant as in farm seeds, but nevertheless these or similar terms are frequently used by vegetable seedsmen.

WHEN TO BUY.

Because of fluctuations in seed prices it is difficult to determine when is the best time for the farmer to buy. To the price paid by the seedsman in the fall and early winter certain carrying charges might properly be added such as interest, insurance, storage, shrinkage, and overhead, accruing until the seed is sold in the late winter or early spring. Theoretically, then, the farmer who purchases in the fall avoids having to pay for these charges and therefore can buy his seed cheaper in the fall than in the spring. As a matter of fact, however, seed occasionally is cheaper in the spring at planting time than earlier. So many factors enter into the subject of seed prices such as carryover, current production, demand, general quality, weather conditions in the spring, transportation difficulties, exports and imports, and prices of other agricultural products, that they can not be discussed within the limits of this bulletin.

In view of the fact that seed prices are just as apt, if not more likely, to be higher at planting time than during the fall or winter, it would seem advisable for more farmers to buy their seed early, because usually the quality of the seedsmen's stocks early in the season is better than later, the seed that is obtained early is sure to be on hand when needed for sowing, and it may be tested thoroughly and replaced by other seed if found to be unsatisfactory. Of course, many farmers are unable to decide definitely in the fall or winter upon the acreage that will be devoted to the various crops, and if they are able to reach a decision early, unusual weather conditions prevailing at planting time may upset their plans entirely. It is believed, however, that a much larger percentage of farmers undoubtedly could and should make their seed purchases earlier than they do at the present time.

WHAT TO BUY.

In seeds as in many other things the best is usually the cheapest. The real cream of the seed crop is generally comparatively small and sold out long before the planting season is over. The advantages in using the best brands or grades of seed are so obvious that some of them will simply be enumerated as follows: Less seed is required per acre, there are fewer weed and other foreign seeds, and stronger, healthier plants are generally produced at the outset.

The purity and germination tests of the best brand or grade of seed offered by a seedsman vary somewhat from year to year and even in the same season, depending upon climatic and other conditions prior to, at, and subsequent to harvesting and thrashing. The average tests for the best grade sold by the leading seedsmen in this country are shown in Table 3. In that table is also given the commonly accepted weight per bushel, because farmers in many sections still buy and sell seed on the bushel basis. The cental system of trading or the 100-pound basis is simpler and quicker, and disputes are avoided over the number of pounds that should be considered as a bushel of those kinds of seed for which various States have established different bushel weights.

TABLE 3.—*Average purity and germination tests of best commercial grade of seed and commonly accepted weight per bushel.*

Kind of seed.	Purity.	Germination.	Weight per bushel.	Kind of seed.	Purity.	Germination.	Weight per bushel.
	Per ct.	*Per ct.*	*Pounds.*		*Per ct.*	*Per ct.*	*Pounds.*
Red clover	99.4	92.4	60	Siberian millet	97.9	92.7	50
Alsike clover	98.3	91.5	60	Hungarian millet	97.5	92.4	48–50
White clover	96.9	90.8	60	Japanese millet	96.4	88.9	32–35
Crimson clover	98.2	91.2	60	Broom-corn millet	99.3	92.1	50
Sweet clover (hulled)	98.9	89.6	60	Amber sorgo	97.9	88.2	50
Bur clover (unhulled)	....	....	10	Orange sorgo	97.9	88.5	50
Lespedeza	93.9	82.1	25	Sumac sorgo	98.3	90.5	50
Alfalfa	99.5	91.4	60	Sudan grass	98.0	91.1	32
Timothy	99.6	93.5	45	Kafir	98.1	91.3	56
Redtop	93.2	90.5	[1] 14	Milo	97.7	91.2	56
Orchard grass	86.9	86.6	14	Feterita	97.9	91.1	56
Kentucky bluegrass	83.0	78.3	[2] 14	Rape	99.2	91.8	50
Bermuda grass	91.5	77.9	35	Wheat	98.8	94.4	60
Bromus inermis	87.7	91.8	14	Corn (field)	99.3	94.0	[3] 56
Meadow fescue	97.8	91.2	22–24	Barley	98.2	93.5	48
Italian rye grass	97.9	83.5	24	Oats	98.6	95.0	32
Perennial rye grass	97.9	83.6	24	Rye	97.8	91.8	56
Hairy vetch	98.7	89.0	60	Flax	98.5	87.3	56
Spring vetch	98.7	92.3	60	Buckwheat	98.6	92.7	48–52
Golden millet	98.8	92.9	50	Cotton	98.0	85.0	30–32
Common millet	98.0	93.5	50				

[1] Fancy recleaned, solid redtop seed weighs 30 to 38 pounds, or more, per measured bushel.

[2] Fancy recleaned Kentucky bluegrass seed weighs 19 to 28 pounds, or more, per measured bushel.

[3] Shelled.

HOW TO BUY.

Regardless of whether the farmer buys seed from his neighbor or local dealer, from growers or shippers in surplus producing areas, or from mail-order seedsmen, he should first obtain a representative sample of it and test it for purity and germination, or buy it subject to satisfactory tests. If found to be satisfactory he should insist that the seed shipped or delivered to him be fully equal to the sample on which his purchase was based. Waiting until the last minute to buy precludes this procedure but nevertheless does not affect the soundness of the advice. Furthermore, precautions should be taken to see that the seed is tagged in accordance with the State seed law. If the farmer happens to live in one of the 10 States that do not have seed laws, tests should be requested of the dealer or the seed should be bought subject to satisfactory tests. Though the intentions of a reputable seedsman may be of the best, mistakes will occur and a lot of seed will at times get mixed or deteriorate in a seedsman's warehouse. Practically all of the larger seedsmen and many of the smaller ones sell their seed with a disclaimer similar to the following:

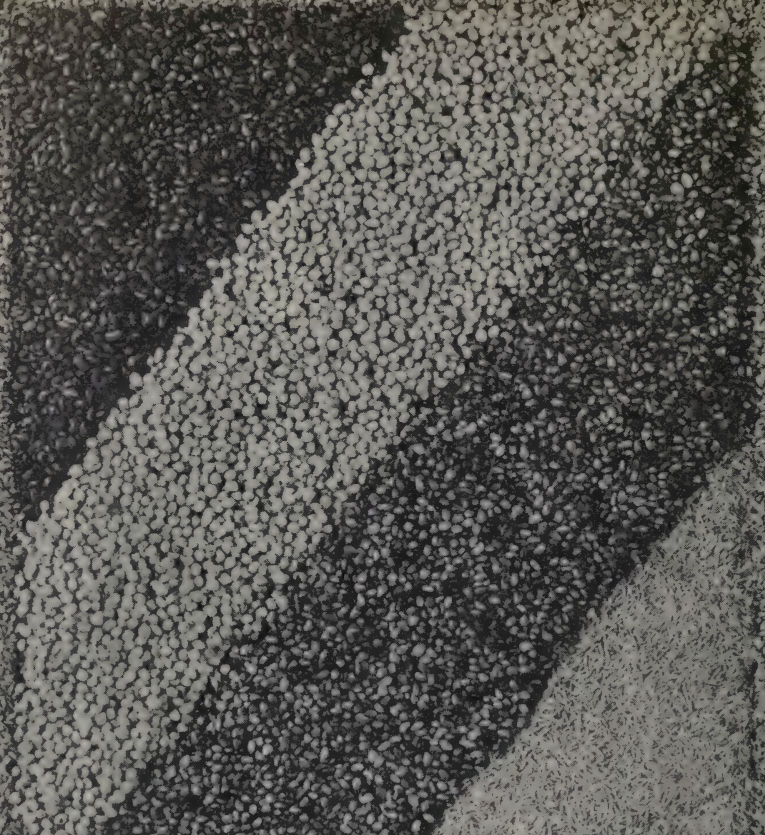
"We give no warranty, express or implied, as to description, quality productiveness, or any other matters of any seeds, plants or bulbs we send out, and we will not be in any way responsible for the crop. If the purchaser does not accept the goods on these terms, he must notify us at once, and we will give instructions for the disposition of goods." Although some seedsmen camouflage this disclaimer by explanatory remarks or by using different words, the meaning generally is essentially the same. The farmer, therefore, should not conclude erroneously that a seedsman is unreliable because his tag, invoice, catalogue, or price list contains this disclaimer. Without attempting to discuss the arguments for the "seedsman's disclaimer" pro and con, the fact remains that reputable seedsmen stand back of their seeds and do not knowingly and willfully sell seeds that are unfit for planting purposes.

SUMMARY.

In the foregoing the importance of seeds to the farmer, the reasons for purchasing seeds, the sources from which he obtains them, the preparation for market given seeds by the grower, how and where the grower sells his seed, and where, when, and how the farmer-purchaser obtains seed have been discussed. It has been pointed out that the individual farmer may be a seller or buyer of seeds, or both. The success of the farmer seed seller depends largely upon the care exercised in proper thrashing, cleaning, sacking, sampling, testing, tagging, and storing of seed. He may dispose of his seed to neighbors, other farmers, local dealers or shippers, traveling seed buyers, distant seedsmen, or by advance growing contracts. In general the profitableness of seed production is dependent upon seed supply and demand, quality, prices of other commodities, and the seller's ability to find the best outlet. The supply of most seeds usually equals or exceeds slightly the demand, but is not always economically and efficiently distributed. The supply of fancy quality and superior strain seed frequently, however, is insufficient to meet the demand.

The farmer who has to buy seed may purchase it locally from farmers or dealers, from traveling seed salesmen, from growers and shippers in surplus seed producing areas, or from mail-order seedsmen. The best time to buy varies from year to year and is influenced by many factors but there are some distinct advantages to be gained through early purchases. The farmer should obtain samples as well as prices from various dealers, if his purchases are large, and test the samples for purity and germination. He should insist that seed shipped to him be fully equal to the sample on which his purchase was made. The better grades should be bought and for his guidance a table of purity and germination percentages has been given. The cental system should be used more generally because of the advantages it offers over buying by the bushel. Much money may be saved by the farmer in intelligent seed purchases which in turn may lead, through the buying and planting of better seed, to larger returns from increased production on a smaller acreage.

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1921



FARMERS' BULLETIN 1233
UNITED STATES DEPARTMENT OF AGRICULTURE

TOMATOES *for* CANNING *and* MANUFACTURING

THE TOMATO is third in value of the vegetable crops. A large portion of the crop is canned or made into soups, purees, etc.

In the United States from 200,000 to 300,000 acres are devoted to the crop annually for canning and manufacturing purposes. The yield is about 1,000,000 tons per annum.

The industry is widely scattered over the United States, but Maryland, New Jersey, Virginia, Indiana, and California produce a large part of the crop.

The practice of a farming system that will keep the soil well supplied with available plant food is essential to success.

Good soil, good seed, strong well-grown plants, careful setting, and good cultivation are essential to good yields and satisfactory returns.

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief

Washington, D. C. October, 1921

TOMATOES FOR CANNING AND MANUFACTURING

JAMES H. BEATTIE,
Horticulturist, Office of Horticultural and Pomological Investigations.

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IMPORTANCE OF THE CROP.

The tomato is one of the few vegetables of American origin that have attained great commercial importance. Introduced into the United States about 1800, it was for a long time looked upon largely as an ornamental plant. Owing to its relation to the nightshade family, it was regarded with suspicion and was said to be poisonous, and it was not until after this strong prejudice had been broken down that its cultivation began to attract attention and its use became general.

About the middle of the last century canned tomatoes were introduced as an article of trade, and the tomato-canning industry soon attained considerable importance. In 1887 the total pack of canned tomatoes in the United States was about 3,000,000 cases, each case containing two dozen No. 3 cans, each holding approximately 1 quart.

Tomato production has grown until at the present time (1921) the tomato occupies third place among the vegetable crops in value, being exceeded only by potatoes and sweet potatoes. The average annual pack of canned tomatoes for the 10 years ended with the season of 1920 was approximately 12,794,610 cases of No. 3 cans or their equivalent. In addition to the tomatoes canned, large quantities were used for the making of soups, purees, and pulp.

The total acreage and yield for the United States for the years 1918, 1919, and 1920 for canning and manufacturing purposes was approximately as shown in Table I.

TABLE I.—*Approximate acreage and yield of tomatoes used for canning and manufacturing purposes in the United States in 1918, 1919, and 1920.*

Items of comparison.	1918	1919	1920
Area grown..acres..	317, 102	195, 645	244, 745
Yield..tons..	1, 323, 059	724, 912	1, 003, 358
Canned product........cases (each containing 24 No. 3 cans)..	15, 882, 372	10, 809, 660	11, 368, 000

The popularity of the tomato, as well as of the canned products made from it, is due to its pleasing acid taste, which is retained to a very large extent in the manufactured goods, and to its cheapness. Tomatoes, especially those canned whole, are very similar to the raw product, as the treatment in canning does not materially change the character of the vegetable.

DISTRIBUTION OF THE TOMATO-CANNING INDUSTRY.

The tomato is a crop requiring a moderately warm climate and a long growing season for its best development. In the Northern States where the frost-free season is too short for maturing the crop out of doors it can be grown by starting the plants indoors, thus prolonging the growing season by several weeks. By following this practice, it is possible to grow tomatoes in a commercial way in regions where the industry could not otherwise flourish. In climates where its growth is not interrupted by frost, the tomato is a perennial plant, but in the portions of the United States where the tomato-canning industry has attained its greatest importance, the tomato is treated as an annual.

Climatic conditions, nearness to market, labor supply, soils, and other factors have all had an influence in the development of the industry in Maryland, California, Indiana, Missouri, Delaware, New Jersey, New York, Utah, Illinois, Kentucky, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia, where the major portion of the tomatoes grown for canning and manufacturing are produced, the volume of the pack in the several States being in the order mentioned.

The geographical distribution of the industry is indicated in figure 1, each dot on the map indicating a factory devoted to the canning or the manufacture of tomatoes into soups, etc. While many of these factories may be operating under serious economic disadvantages, the map shows that tomatoes for canning and manufacturing are being grown and packed over a considerable portion of the United States.

While the high temperatures and hot sun of the lower South are not well suited to the growing of tomatoes for canning and the northern limit of their growth is established by the short growing season of the northern portion of the United States, it does not follow that the present distribution of the industry is in all cases economically sound. Within the climatic range to which the tomato is adapted it is not particularly exacting as to soil requirements. Any good soil suitable for general farm crops can readily be adapted to the growing of tomatoes for canning. The plant requires from 80 to 110 days from seed to come into bearing, but about one-third this period can be spent in the greenhouse, the hotbed, or some other protected place, and the growing season can in this way be considerably lengthened.

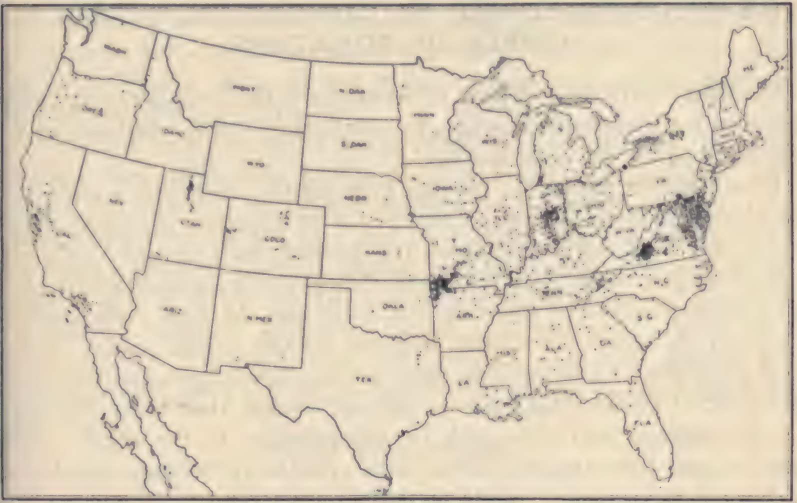

FIG. 1.—Map of the United States, showing the distribution of the tomato-canning industry. Each dot represents one canning, soup, puree, or other tomato-product factory.

The plant bears until killed by frost unless injured by drought, insects, or diseases; hence, the longer the producing season the higher the yields. During the producing period the plant does best when the day temperature is from 80° to 90° F. and the night temperature about 60°. The crop requires about the same amount of moisture as other farm crops grown in the sections to which tomatoes are adapted. From a consideration of these factors, it is apparent that large areas, ying in a broad belt between the extremely hot lower South and the short growing season areas of the North are, as far as the general requirements of the plant are concerned, well adapted to the growing of omatoes for manufacturing purposes. The very fact that the tomato can be so easily produced under a wide variety of conditions has in he past led to the development of the industry in sections where there have been and are few economic reasons for its continuance. In sections where the soil is very light, requiring large quantities of organic material and commercial fertilizers and where the crop is easily injured by drought, and where, as a rule, under such conditions the yields are low, growers are at a serious disadvantage. When the crop is grown for canning only and where nearness to market is not essential, it would be better to center the industry in sections where these unfavorable conditions do not exist, provided the other essential factors are present. The tendency at the present time is toward either the moderate-sized factory located near the source of supply of tomatoes or to the small farm cannery handling the product of one or two farms and often making some special product.

METHODS FOLLOWED BY CANNERS TO OBTAIN A SUPPLY OF TOMATOES.

Canners secure their supply of tomatoes either by contracting with growers for a definite acreage, by growing them themselves, or by buying them in the open market.

It is difficult, however, for the canners to safeguard a sufficient supply without some form of contract with growers. In some cases, a plan has been devised whereby the growers are guaranteed a fixed minimum price for their tomatoes, this price being sufficient to return them the cost of growing the crop, and the final settlement is made on the basis of the price received for the canned goods. Some such plan as this may obviate many of the difficulties experienced in the past. Canners and growers should realize that their interests are in common and that each is indispensable to the other. The canner must have tomatoes if he is to operate his factory, and he in turn gives the grower a ready market for his crop.

Some of the large canning companies now produce a large percentage of the tomatoes they require on land either owned or leased by them. Such companies maintain a farm department, with the necessary equipment to plant, care for, and handle the crop. This plan has many points in its favor, but is hardly practicable for any but the small canner handling the product of his own farm or for the very large concern able to command sufficient resources to produce the crop along the most advanced lines. Where a sufficient supply can be obtained from the farmers, most firms prefer to devote their whole energies to the manufacturing end, leaving the growing of the crop to the farmers.

In parts of the Tri-State territory, consisting of Maryland, Delaware, and New Jersey, where in the past more than half of the tomatoes grown for canning have been produced, some growers sell the early crop on the market when prices are high and dispose of the later portion to canners or soup manufacturers. In this way a higher average price is received for the crop, and the plan often works to the advantage of both growers and canners. Few canners depend on buying their entire supply on the open market, preferring as a rule to contract for at least 90 per cent of their requirements. Some large manufacturing firms follow the practice of buying the surplus stocks of tomatoes on certain markets available to them when the price drops to a specified point. Part of the surplus is thus taken off the market, and this acts as a safety valve, the growers being guaranteed against the entire loss of this part of their crop.

Whether the farmers have a direct financial interest in the cannery end of the business or not, there should be sufficiently close relations between the farmers and the canners to permit the employment of every agency to increase the yields and make the industry a profitable one to both, for unless the business gives the growers and canners reasonable returns, they can not be expected to continue the production and the packing of this crop.

Within the past few years the growing and canning of tomatoes have not been uniformly profitable to growers and canners. The average yield for the past few years in the Tri-State territory has been less than 4 tons per acre and in Indiana less than 5 tons per acre. Some growers in these States have uniformly obtained much higher yields, 10 to 12 tons per acre being quite common. Growers who expect to make a success of tomato growing must obtain good yields, and the purpose of this bulletin is to point out some of the practices which have proved successful in increasing the yields of tomatoes.

CROP ROTATION.

A crop rotation that will keep the soil in good physical condition and well supplied with organic matter is particularly desirable on farms where tomatoes are grown year after year. The rotation should not include such crops as potatoes, peppers, or eggplants, as hese are related to the tomato and liable to spread the diseases affecting the tomato. A rotation that includes at least one crop or combination crop of clover or cowpeas is extremely desirable. It is oo often the practice to relegate the tomato crop to the poorest part of the farm, using the good ground for other crops. The crop hould be placed on good ground if success is to be expected. For details as to the rotation best suited to local conditions, the county gent should be consulted.

It is often possible to add materially to the organic matter in the oil by growing cover crops between the rows of tomatoes, sowing hese crops after the last cultivation of the tomatoes. When it is he plan to use such crops, the tomatoes are usually set in rows 5 or 6 feet apart and 3 feet apart in the rows, this method of planting giving practically the same number of plants per acre as when set at standard planting distances, as practiced in the past. Where it is possible to get a stand of crimson clover, this is an ideal crop for this use. Cowpeas and soy beans are also extensively used for this purpose.

The particular method to be followed must be determined by the conditions found on each farm, but the purpose should be to keep the ground occupied at all times with some crop that is adding vegetable matter to the soil, preferably one that is adding plant food in the form of nitrogen. It should be remembered that even the non-nitrogen-gathering green-manure crops add to the fertility of the soil by making available much of the insoluble plant food found in most soils.

SOILS FOR TOMATOES.

Tomatoes can be grown on a wide range of soil types. They are successfully produced in commercial quantities upon soils varying from mucks to clays and from clays to comparatively light sands. Light soils, however, are open to the objection that they suffer severely from drought and are hard to keep supplied with organic matter and available plant food. On the other hand, such soils are easier to work, are usually earlier, and the cost of preparing the ground and planting and caring for the crop is less than for heavier soils. It is believed by many authorities that tomatoes grown on light soils are of a better quality than those grown on heavier soils.

The tomato is very sensitive to poorly drained soil, and such ground should never be used for the growing of this crop. The land should be in a high state of fertility and in good physical condition as a result of proper treatment during previous seasons and should not have been in tomatoes, potatoes, peppers, or eggplants for at least three years. Crops which are closely related to the tomato may serve as host plants for various diseases which may later attack the tomato crop.

PREPARATION OF THE SOIL.

Where fall plowing can be done without sacrificing well-established cover crops, it is in many cases desirable. On heavy soils, where it is possible to practice it without injury to the soil through leaching and washing, fall plowing is a good custom, as it promotes more thorough decay of roots and other organic matter in the soil and, owing to the alternate freezing and thawing, puts the soil in better physical condition. Plow as deeply as the soil will permit, and gradually increase the depth of plowing by half an inch each season until the soil is at least 8 inches deep. It is not desirable to increase the depth of plowing suddenly so that large quantities of subsoil are brought to the surface, but through gradually deepening the plowing the soil can be increased in depth without affecting the present crop. The final result will greatly improve conditions for the growing of tomatoes and other crops. In case a cover crop or sod is to be plowed under, disking is recommended before plowing, as this will hasten the decay of the material being turned under. The preparation of the land after plowing should be more thorough than is ordinarily given for general farm crops. Before setting the plants and topsoil should be well pulverized to a depth of 3 or 4 inches.

MANURE.

Many growers prefer to apply stable manure to the crop preceding tomatoes rather than to the tomato crop itself. Unless the soil is exceedingly rich in available plant food, however, there is no objection to the application of moderate quantities of well-rotted stable manure directly to the tomato crop. If long, strawy manure is used, it should be plowed under. If the manure is short, it may be applied broadcast as a top-dressing and worked into the soil before planting. The application of 10 to 12 tons per acre is desirable, but owing to the increasing scarcity of stable manure growers of canning tomatoes as a rule can not depend upon this material for the maintenance of their soil. They should, through proper farm practices, keep the soil well supplied with organic matter obtained by growing and turning under such crops as crimson clover, cowpeas, soy beans, rye, vetch, and winter oats.

LIME.

Where lime is needed to correct soil acidity, it should by all means be used before attempting to grow a crop of tomatoes. There is no safe rule for the application of lime to tomato land, but, generally speaking, the lighter soils used for the growing of tomatoes have a sufficient supply of lime. Heavier soils are more likely to need lime, but in all cases an actual test is necessary. Applications of 1,000 to 2,000 pounds per acre of ground limestone will usually be sufficient, as moderate applications at frequent intervals have been found to be more desirable than heavy applications at less frequent intervals. Where quick results are desired, a small quantity of ground stone lime or hydrated ground lime may be used.

COMMERCIAL FERTILIZERS.

The judicious use of commercial fertilizers will, in most cases, pay good returns; but, as pointed out in previous paragraphs, it is far better to use soil that is in good physical condition and well supplied with plant food through years of proper treatment than it is to depend upon heavy applications of commercial fertilizer to improve the crop.

However, in the older tomato-growing sections the best growers use considerable quantities of commercial fertilizer directly on the tomato crop, and it pays them good returns. A few years ago it was the practice to apply fertilizers containing 4 per cent nitrogen, 8 per cent phosphoric acid, and 10 per cent potash; but during the past few years, owing to the scarcity of potash, this has been cut down until at the present time mixtures containing 4 per cent nitrogen, 8 per cent phosphoric acid, and 4 per cent potash are about as high in potash as can be obtained at reasonable cost. A mixture with 2 per cent nitrogen, 8 per cent phosphoric acid, and 3 per cent potash gives good results, and on most soils this can be used profitably at the rate of about 1,000 pounds per acre. When used at this rate, 600 pounds should be broadcasted before the field is laid off and 400 pounds should be applied in the rows about 10 days before setting the plants.

Under certain conditions it is advisable to use an additional side dressing of nitrate of soda or sulphate of ammonia, and when this is done it is usually applied from four to six weeks after setting the plants, at the rate of 100 to 150 pounds to the acre. In using nitrate of soda or sulphate of ammonia the fertilizer should be applied a few inches from the plants, care being taken that none of it falls on the foliage.

As a rule, the lighter soils demand heavier applications of fertilizer than the heavier ones.

When moderate applications of manure are made, 400 pounds of a fertilizer with 4 per cent nitrogen, 8 per cent phosphoric acid, and 4 per cent potash per acre in rows under the plants will be sufficient.

VARIETIES AND SEED.

Poor yields of tomatoes are often due to the use of poor seed and unsuitable varieties, and in some cases to the use of mixed seed. Next to poor soils the greatest menace to the industry is poor seed, especially the promiscuous cannery-run seed which is saved from catsup and tomato pulp manufacture. Cannery-run seed is often a mixture of varieties, frequently carries disease affecting the fruits as well as the young plants, and is never saved from selected stock. Its use can not be too severely condemned. Two ounces of good seed will produce an abundance of plants to set an acre. Even though good seed may be expensive, its use is advisable.

Satisfactory tomato seed suited to the growers' conditions can be purchased from dealers who have made a specialty of its production.

It is also possible to secure excellent results by individual growers or associations of growers saving their own seed. If the individual grower desires to work alone, he can select a few plants of the type he desires and save his seed from these plants. If it is advisable for an association of growers to unite their efforts and save enough seed for the use of the entire membership of the association, this work can readily be done by one or two growers who have satisfactory facilities for producing the seed. The selection of seed from a high-yielding field will help, but such selection will never develop a very high strain, since the plant itself is the unit that must be considered.

Where fields are set aside for seed purposes, individual plants of the desired type should be marked and the product of these plants taken for seed from which to grow the plants for next year's crop. Tomatoes from the undesirable plants in the field should be gathered separately and used in such a way that none of the seed from them becomes mixed with that of the selected plants. There is little to be gained from the saving of seed from fine, large tomatoes irrespective of the plant from which they have been taken. Provided the proper type is selected, the seed from the small tomatoes borne on selected plants is just as desirable as that from the larger tomatoes. Through the home or community selection of seed good strains can soon be developed.

Considerable progress has been made within the past few years in the development of strains of tomatoes resistant to wilt. Among these may be mentioned the Wilt-Resistant Stone, Wilt-Resistant Greater Baltimore, Norton (a wilt-resistant Stone), Arlington (a wilt-resistant Greater Baltimore), and Marvel (an early wilt-resistant variety). For early tomatoes the Bonny Best, John Baer, Chalk's Jewel, and Delaware Beauty are satisfactory varieties. For late tomatoes the Greater Baltimore, Stone, Paragon, Success, Matchless, and Red Rock are satisfactory.

GROWING THE PLANTS.

Strong well-developed plants are essential to the production of profitable crops of tomatoes. The method to be followed in obtaining these plants must be determined, to a large degree, by the geographical location of the grower, by the equipment available, by the time in the season the plants are needed and by the desired size of the plants themselves. As already pointed out, the growing season can be lengthened several weeks by growing the plants indoors, as it is possible with proper facilities to have them well advanced when set in the field. In some sections the canners grow the plants, charging their growers the cost of the plants. In other cases, several farmers unite to grow enough plants for the needs of all, dividing the cost among them. Perhaps the most general practice is for the individual tomato growers to start their own plants, making use of whatever facilities they may have. Whatever the method followed in obtaining the plants, the aim should be to secure plants that are free from disease and that can be moved from the plant bed to the field with a minimum amount of shock. It is obvious that the grower who is so situated that it is possible for him to grow his plants can, with proper precautions, produce stronger and healthier ones than would be possible with plants grown at a distance. Such plants can be moved from the plant bed to the field without much shock to them, which is sure to result when they are shipped long distances.

THE SEED-BED METHOD.

The method of growing tomato plants in the open on a specially fitted piece of land is very largely followed in Delaware, Maryland, New Jersey, Virginia, and other sections where canning tomatoes or plants for sale to canners are grown. The common practice of using the same area year after year for the seed bed is open to the objection that such ground is liable to become infected with diseases, such as collar rot. When it is necessary to use an old seed bed, it should be sterilized with steam, hot water, or formalin. Such a practice is an effective insurance against certain diseases and is well worth the necessary effort. Directions for sterilizing seed beds may be found in Farmers' Bulletin 996, United States Department of Agriculture.

Unless it is possible to sterilize the seed bed thoroughly each year, it is better practice to select a fresh area for the plant bed. A desirable and common practice is to burn large quantities of brush on the area, thus destroying many weed seeds and adding considerable quantities of potash to the soil.

The seed bed is, as a rule, prepared in the early spring, and as soon as the ground is warm the seed is sowed in drills from 2 to 4 inches apart with from three to five seeds to the inch. It is the aim to cover the seed about half an inch deep, provided the soil is of a light texture, and not more than a quarter of an inch deep if the soil is of a heavy or clayey nature. It is an excellent plan to mark the ground off with some suitable marking device, place the seed in position in the drills, and cover it with a screened mixture of half leaf mold and half sand. After the plants are well up, they should be thinned, so they will stand about half an inch apart in the rows. Many growers do not practice this thinning, on account of the labor involved, but it is extremely desirable.

This method of growing tomato plants, while very largely followed, is open to several very serious objections. In the first place, the plants can not be produced sufficiently early in the season for the best results. Again, plants grown in seed beds without transplanting are never as strong and healthy as transplanted plants. While the method gives great numbers of plants at low cost, it should not as a rule be followed. One of the greatest handicaps to the tomato industry to-day is the use of poor plants, and the seed-bed method of growing plants as a rule does not give good plants. It is far better to employ a method that will give better plants, even though the cost of these plants be higher.

THE HOTBED-COLDFRAME METHOD.

A method frequently followed, and one which usually gives good results, is to sow the tomato seed in hotbeds heated either by manure, coils of steam, hot-water pipes, or a flue some six weeks before the time to set the plants in the field. The seed is sown in drills, as in the case of the outdoor seed bed, although it may be sown more thickly in the row than would be permissible were the plants to grow in this position until taken to the field. About 10 days to two weeks after sowing the seed the plants should be ready for transplanting to coldframes fitted with sash or muslin covers, to protect them from occasional frosts. These coldframes have from 3 to 4 inches of thoroughly fine and well-rotted potting soil, in which the plants are set, spacing them about 3 inches apart each way. They are allowed to grow in this position until time to move them to the field. During their growth in the coldframe the sash or cover is gradually removed, keeping the temperature as low as practicable consistent with safety to the plants. This practice tends to give strong, stocky plants that will not suffer much shock when shifted to the field. During the later stage of growth the covers are removed entirely. (Fig. 2.)

When the time comes to set them in the field, the root system of the plants will have spread through most of the top layers of soil, and the usual practice is to cut the plants apart with a spade or trowel, allowing each plant to retain its square of soil with as little disturbance of the root system as possible. The plants are set in shallow boxes, or flats, and transported to the field, and when set in position with care need suffer little disturbance.

A modification of this method is to transplant plants to flats, or shallow boxes, instead of to the coldframe direct, setting these flats in the coldframe, so that when planting time comes these boxes can be moved to the field and the plants cut apart and set directly into the open ground. When such boxes are available, this plan is an excellent one to follow and with proper care gives strong, healthy plants. (Fig. 3.)

GREENHOUSE-GROWN PLANTS.

Another method that gives good results is to sow the seed in flats in the greenhouse, covering it with leaf mold and sand. (Fig. 4.) When the plants are ready for transplanting they are shifted to paper bands or pots (fig. 5), these being set in flats or directly on the greenhouse benches and kept under suitable temperature and moisture conditions. At the end of about two weeks they are again transplanted to larger bands or to pots and then shifted to an outdoor coldframe and handled as in the case of plants grown according to the second method described.

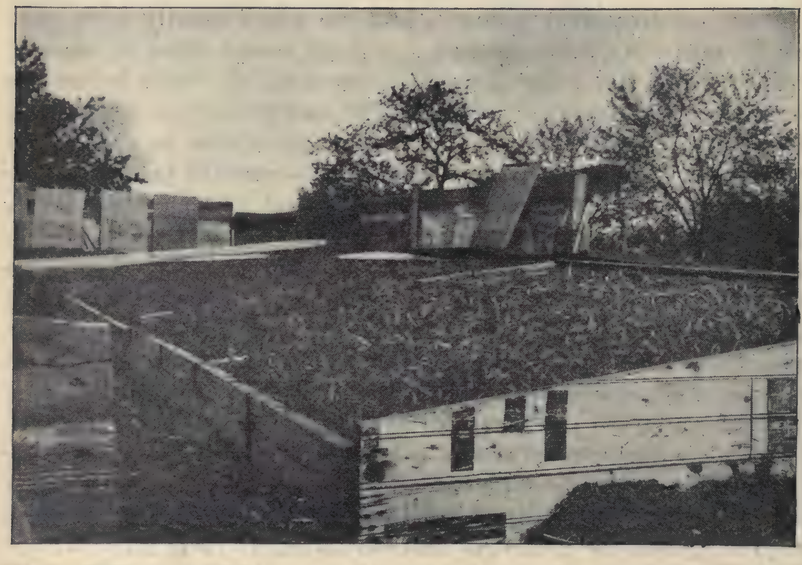

FIG. 2.—Coldframe occupied by a crop of strong, well-hardened tomato plants. The covers are held in readiness for a sudden cold night.

Transplanted plants always have better root systems and are stronger and more stocky than those not transplanted, two transplantings giving correspondingly better results than one. Where the cost of labor is not too high it will pay to grow transplanted plants, as the results from the use of such plants are usually better. Plants of the type shown in figure 6 can be produced by following the method just described.

Whatever the method followed in producing the plants, too much attention can not be paid to the control of conditions under which the plants are grown, as this almost wholly determines the success or failure of the effort. The soil used for the seed beds should always be sterilized. The flats should be filled with thoroughly prepared potting soil made up of 1 part well-rotted manure and 2 parts well-rotted sod. This material should be prepared the season before by composting sod and manure. Some two or three weeks before it is time to sow the seed this compost should be placed either in the hotbed or brought into the greenhouse, so that it will reach a temperature of 60° to 70° F. before the time to sow the seed. If the seed is to be sown in the hotbed, the soil may be placed in sacks or boxes, put in steam boxes, as described in Farmers' Bulletin 996, and thoroughly sterilized. It will be necessary to allow the soil to dry out before placing it in the hotbed ready for the seed. When the seed is to be sown in the hotbed, however, it is best to sterilize it in position by the methods described in the Farmers' Bulletin mentioned. A steam cabinet should be used when the seed is to be sown in flats in the greenhouse. Such a cabinet is inexpensive and can be made of lumber, concrete, or brick. The one shown in figure 7 is constructed of concrete and is so planned that the flats filled with soil can be stacked on a truck and rolled into the cabinet. It is suggested that sterilization equipment be constructed at the cannery, where steam is available.

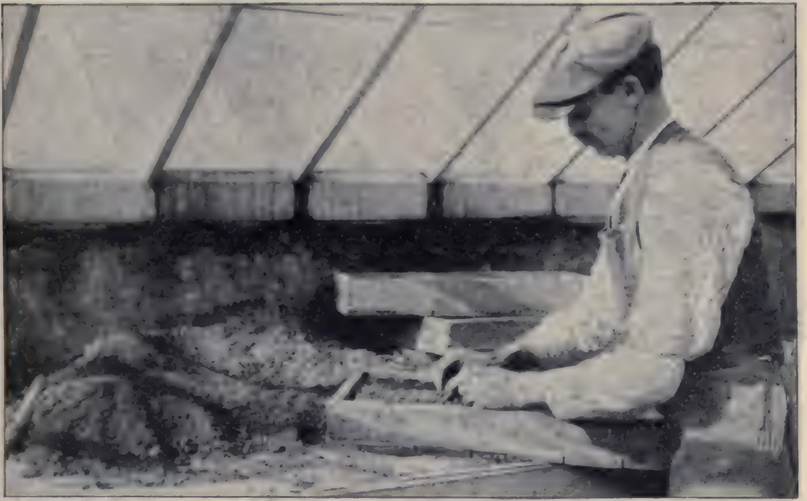

FIG. 3.—Transplanting tomato seedlings to flats, where they are allowed to grow until it is time to set them in the field.

Tomato seed germinates best at a temperature of about 70° F., and care should be taken that the soil is not kept too wet, as moisture is likely to induce damping-off and other diseases.

Many other methods aside from those described are employed in growing tomato plants; whatever the method used, the aim should be to obtain strong, healthy plants sufficiently early in the season so that the plants can be placed outdoors as soon as conditions permit.

Stocky, well-grown, well-hardened plants are well worth the necessary effort required to produce them. Reject all plants that have any appearance of disease, such as mottling of the leaves, curling of the leaves, or discoloration of the stem.

SETTING THE PLANTS IN THE FIELD.

Tomato plants should not be set in the field until danger of frost is past, the actual date depending upon the particular section of the country in which they are grown. It should be the aim of the grower to move the plants to the field with as little shock to them as possible. For this reason, just as much as possible of the root system of the plant should be saved. Tomato plants grown in such a way that they can be transferred to the field without disturbing the root system have a very great advantage over those whose root systems must be more or less injured in removing them from the seed bed and to the field.

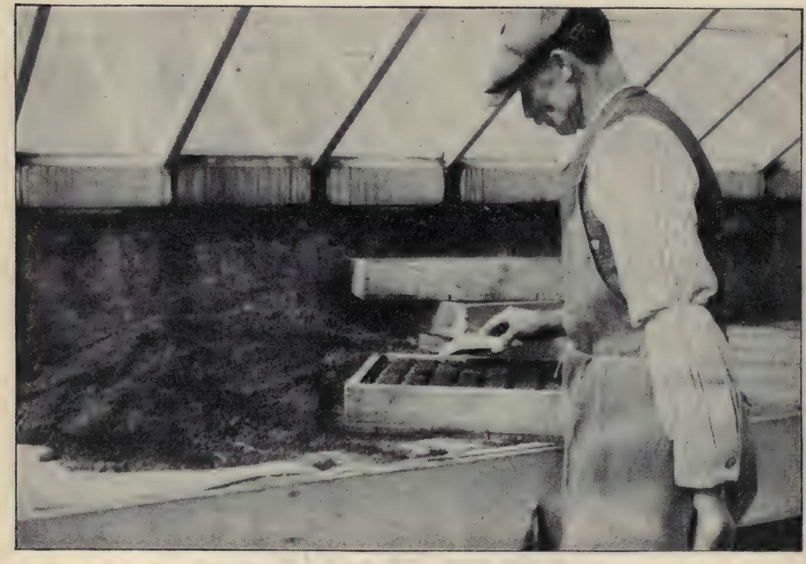

FIG. 4.—Sowing tomato seed in flats in the greenhouse. The seed is covered with sand or leaf mold. As a rule the seedlings are ready to transplant in 10 days.

Planting distances vary, but if the plants are to be sprayed or if green crops are to be planted between the rows at the last cultivation the rows should be 6 feet apart and the plants 3 feet apart in the rows. This distance permits the spraying apparatus to pass between the rows without injury to the plants, and it also makes it possible to seed a large proportion of the ground to such crops as crimson clover and rye, when the last cultivation is given the tomatoes. If the plants are not to be sprayed, they may be set about 4 feet apart each way, or any other distance that gives sufficient room for the development of the individual plants. There is nothing to be gained by planting too close, as the vines will mingle on the surface of the ground, this crowding making it harder to cultivate and gather the crop, with no greater yields than when the plants are set farther apart.

If set in dry weather the plants should be watered in, and it is a distinct advantage to set the plants at a sufficient depth so that but a few inches of the tops will be exposed. Hand planting is necessary where the plants have large quantities of earth adhering, such as is secured by blocking, growing in pots, paper bands, etc. The use of transplanting machines is recommended where plants that have not been transplanted are used. The use of water in machine setting is recommended.

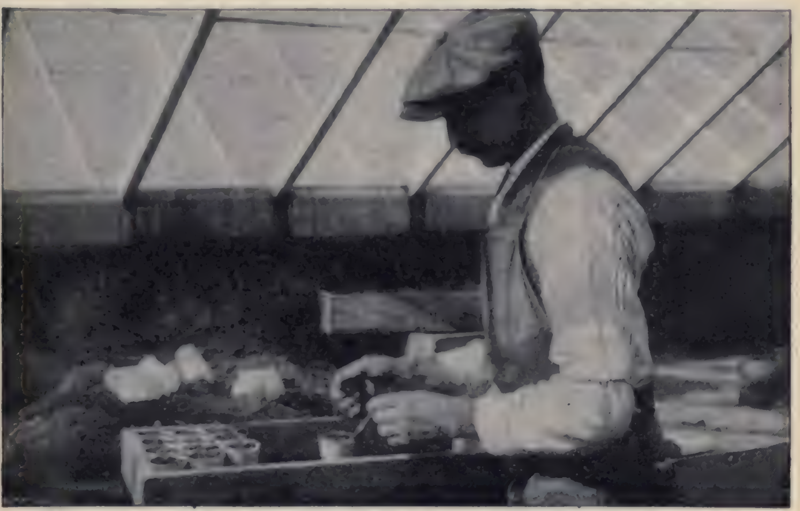

FIG. 5.—Transplanting tomato seedlings to paper pots, which may be set in flats for convenience in handling or set in sand on the greenhouse bench.

CULTIVATION.

Clean, level cultivation is essential to success in growing tomatoes. The field must be kept free from weeds, and it is especially desirable that horse nettle (nightshade) a plant common in some sections of the country and related to the tomato, which spreads certain diseases, be kept out of the field. A good soil mulch should be maintained at all times. The tomato is not a very deep-rooted plant, and frequent shallow cultivations are much better than infrequent deep ones. Cultivation should not be carried on when the vines are wet, as this tends to spread the spores of the leaf-blight fungus. It should continue until the vines cover the ground, but should be given up when the vines are injured thereby. The hoe should be used to keep stray weeds out of the field after that time.

SPRAYING.

To be effective the spraying of tomatoes for disease must be absolutely thorough. It is an exceedingly difficult matter to spray tomato vines thoroughly, owing to the habit of growth of the plant. Much of the so-called spraying of tomatoes is wasted effort, owing to the fact that improper equipment is used or the work carelessly done. Effective work can be done only with a high-pressure power or traction outfit. Spraying should begin about the time the tomatoes begin to set and should be carried on at intervals of 10 days until five applications are made.

For additional information on the control of diseases and insects, write to the United States Department of Agriculture or consult the county agent.

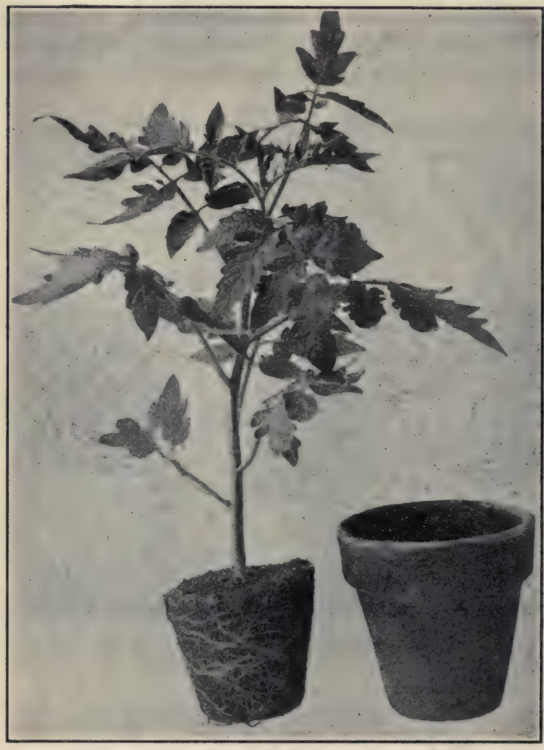

FIG. 6.—A well-rooted, strong, and hardy tomato plant produced by two transplantings. Such plants increase the chances of success.

PICKING AND HANDLING TOMATOES.

Tomatoes grown for manufacturing purposes are usually hauled directly from the field to the factory. Although they are to be used immediately, extreme care should be taken in picking and handling the crop. One of the greatest difficulties in the past in the production of high-quality canned tomatoes has been in getting the raw product to the cannery in first-class condition. The industry has been seriously penalized by carelessness in this respect. The sooner the growers and canners realize the importance of producing a high-quality product, and that such a product can be secured only through the exercise of painstaking care all along the line, the better it will be for the industry.

Tomatoes should be picked when in prime condition for the purpose for which they are to be used. This means that they should be thoroughly ripe, but not overripe. All tomatoes injured or partly decayed should be discarded. It should be the aim of the grower to pick his tomatoes and get them to the cannery in the shortest possible time. It should also be the aim of the cannery to handle the product just as quickly as possible after it reaches the factory. In the past there has been a tendency among growers to pick at too infrequent intervals and among canners to allow the tomatoes to stand around the factory too long before being used.

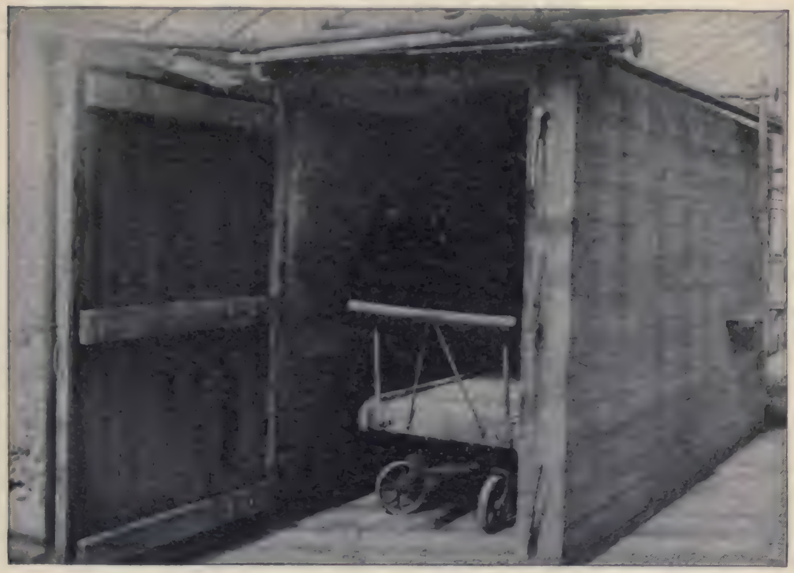

FIG. 7.—A concrete cabinet used for sterilizing soil for the growing of tomato plants.

Tomatoes should not be picked when the vines are wet, as there is great danger that leaf-spot and early-blight, two very serious tomato diseases, will be spread by the hands and clothing of the pickers.

Successful tomato growing depends on good farm practices, good seed, good plants, proper fertilizer, careful planting, clean cultivation, and disease control through spraying and through the use of disease-resistant varieties. Growers who pay due attention to these factors produce crops which give them satisfactory returns.

HOW TO DO IT

DO YOU WANT practical suggestions on how to build a silo, a hog house, a poultry house, a potato-storage house, or how to make a fireless cooker, or other farm home convenience? Are you seeking ideas on how to prepare vegetables for the table, how to care for food in the home, how to bake bread and cake and other appetising foods in an efficient and economical manner? Is there some practical question about your corn or wheat or cotton or other crops, or about your poultry or live stock, to which you are seeking an answer? The answers to thousands of such questions and practical suggestions for doing thousands of things about the farm and home are contained in over 500 Farmers' Bulletins, which can be obtained upon application to the Division of Publications, United States Department of Agriculture, Washington, D. C.

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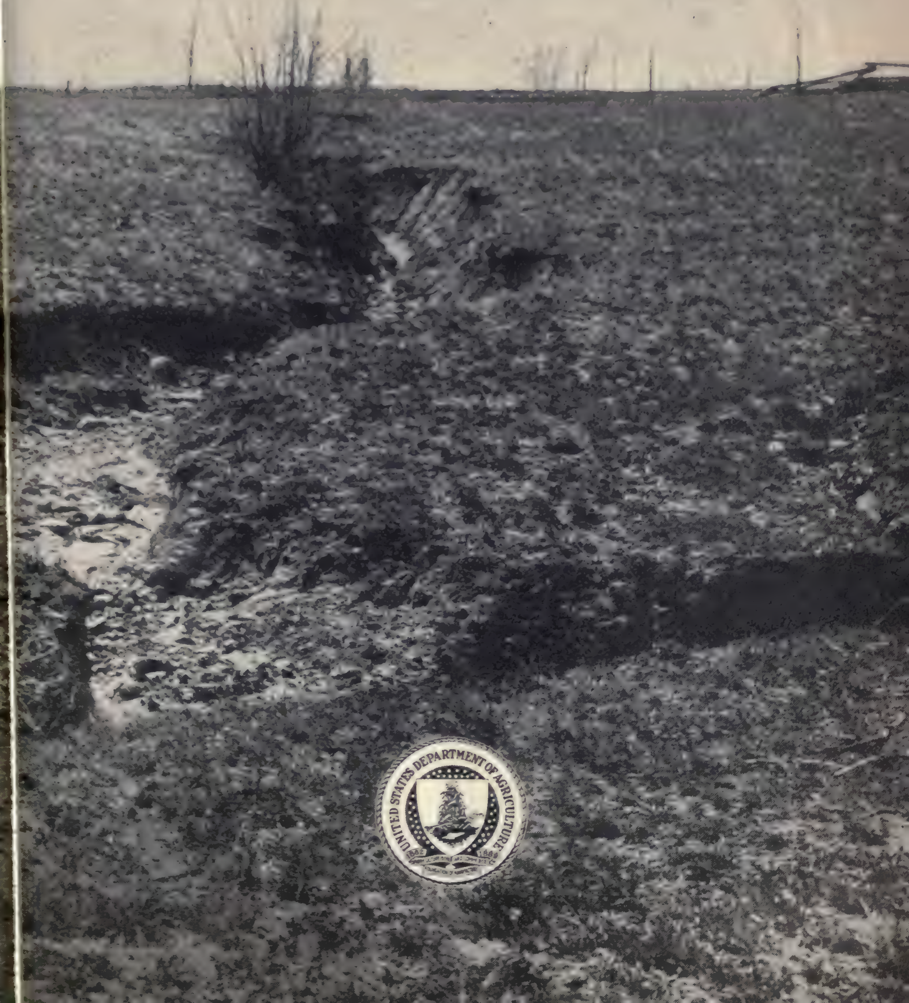
Farmers' Bulletin 1234
United States Department of Agriculture

GULLIES—
How to control *and* reclaim them



GULLYING occurs in every State in the Union. Besides ruining fertile land, gullies interfere with farm operations, undermine buildings, encroach on public highways, endanger the life of stock, and often mar the beauty and lower the market value of a farm. They are also largely responsible for the filling up of reservoirs, streams, and dredged channels, and for the covering of bottom lands with deposits of sand.

Gullies can be prevented by increasing the absorptive capacity of the soil, protecting the surface from erosion, and conducting the surplus water from the field at a low velocity. Gullies can be reclaimed by plowing-in and seeding to grass or timber, or by building soil-saving dams that check erosion and cause the filling of the gully with silt above the dams.

It is recommended that this bulletin be read in conjunction with Farmers' Bulletin 997, Terracing Farm Lands.

Contribution from the Bureau of Public Roads
THOS. H. MacDONALD, Chief
Washington, D. C. February, 1922

GULLIES: HOW TO CONTROL AND RECLAIM THEM.

C. E. Ramser,

Senior Drainage Engineer, Division of Drainage Investigations.

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OCCURRENCE OF GULLIES.

GULLYING occurs in every State in the Union. The Southern States have suffered heavily from gully erosion, as the annual rainfall is large and a large proportion of the land has been devoted year after year to the production of clean-cultured crops, such as cotton, corn, and tobacco.

Gullies are of common occurrence on northern farms also; in many localities they are a serious menace. In a typical case a main gully and its many branches, 15 to 20 feet deep and 30 to 60 feet wide, extended over and cut up into small areas an 80-acre farm, and expensive concrete structures were required to prevent the gully from crossing two highways. The land, practically ruined for farming, would be worth $300 or $400 per acre to-day were it not for the gullies. An old resident stated that 25 years ago there was not a gully on this farm.

RESULTS OF GULLYING.

The worst damage done by gullies is the ruining of fertile farm and through the irredeemable loss of good, fertile soil. Other objecions to gullies are:

They can not be readily crossed with teams and farm implements.

They form a channel for the rapid removal of fertile soil brought lown by surface erosion from the tributary drainage area.

They grow rapidly and often extend through a farmer's premises, undermining and necessitating the removal of residence and outbuildings (fig. 1).

They encroach upon public highways paralleling them and make travel unsafe.

They extend across roadways and undermine bridge structures (fig. 2) often necessitating the building of long and high bridges.

They cause the filling up of reservoirs, river channels, and dredged channels made at great expense (fig. 3).

They furnish most of the sand that is washed from hills and deposited on rich bottom land, making it unproductive (fig. 4).

They present an unsightly appearance and often mar the beauty of a farm, reducing its market value and the value of adjoining farms.

They endanger the life of stock that graze too near the edge of undermined banks.

CAUSES AND TYPES OF GULLIES.

Gullies are caused by erosion due to water collecting and flowing at a velocity sufficient to move and carry away soil particles.

HEAD EROSION.

When plants and soil are unable to retain all of the rain that falls on rolling or hilly land the surplus flows over the surface to a drainage channel at the foot of the slope. If there are no draws or depressions the water travels over the surface to the foot of the slope in broad, thin sheets. Where depressions exist, however, the water is led into the depressions. It gathers from above and from the sides of the depression and forms a stream with power to wash away the soil proportional to the stream's size and velocity. If the depression is not sufficiently protected by grass or other means to prevent erosion, a gully begins to form which enlarges with each succeeding rain.

Natural hollows are not the only places where gullies start. They may start at any place on a slope where opportunity is afforded by artificial means for the water to collect and form a small stream. Driving a wagon down a slope when the ground is soft leaves wagon tracks that may later develop into gullies (fig. 5). A gully may be started by dragging a plow down a slope. Mole holes and cattle paths down a slope are common causes of gullies. One of the commonest ways to start gullies is to plow or cultivate straight up and down a slope (fig. 6). A dead furrow extending down a slope may rapidly develop into a deep gully.

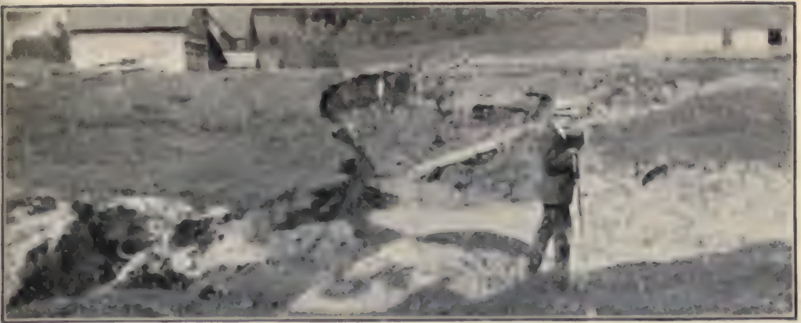

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FIG. 1.—Gully encroaching on farmer's premises which unless controlled will undermine the buildings. Near Alma, Wis.

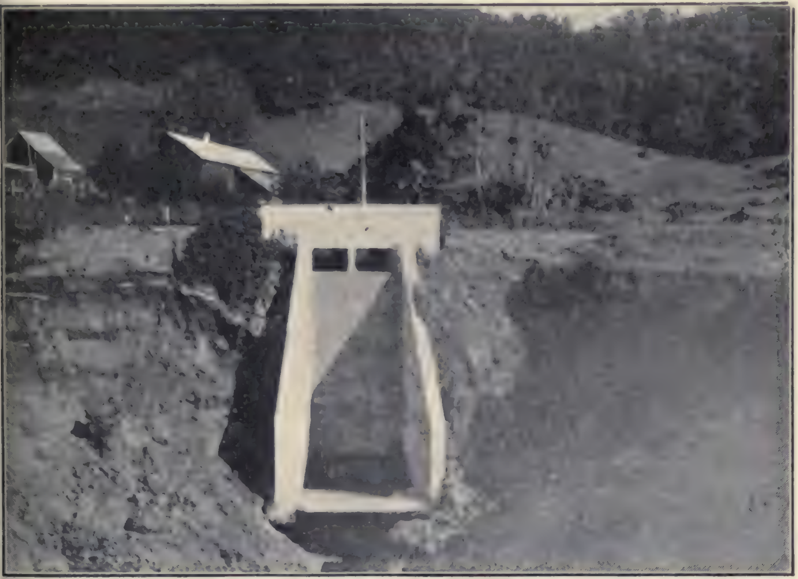

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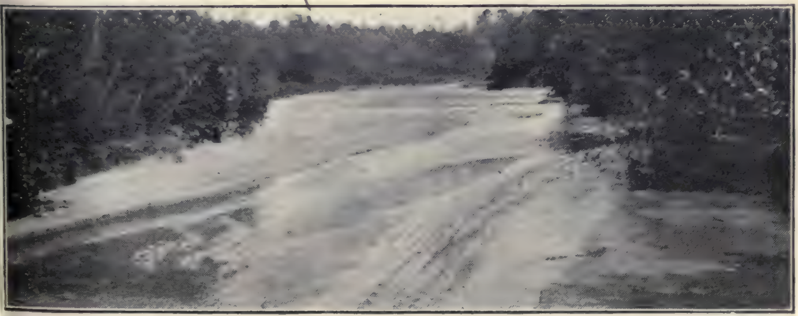
FIG. 2.—Road culvert and concrete drop inlet built at great expense to prevent gully from crossing the highway. It is shown partly undermined and later was washed out. Near Alma, Wis.

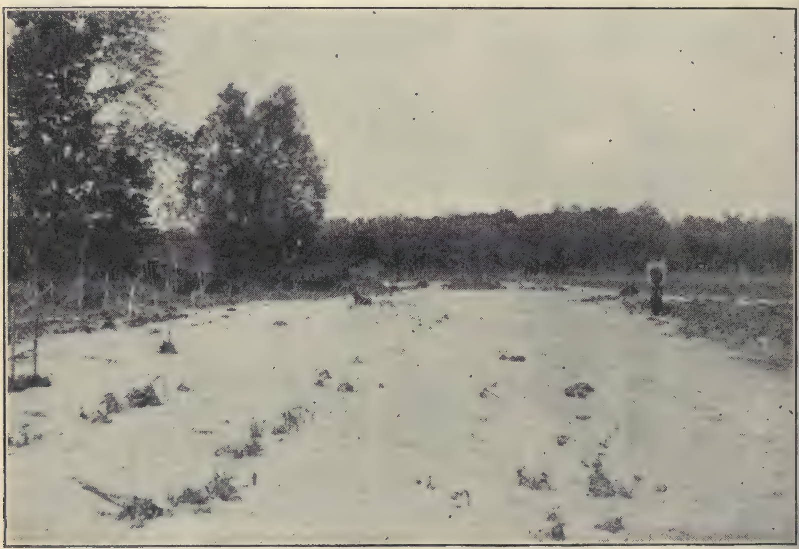


B. P. R. D-949

IG. 3.—Channel nearly filled with sand washed from adjoining hills, requiring dredging at great expense to provide drainage for the bottom lands. Gwinnett County, Ga.

DITCH EROSION.

Where head erosion occurs on the upper part of a watershed it makes channels for the rapid removal of the excess water from the field slopes and delivers the water in large volumes to the natural drainage channels at the foot of the slopes. The capacity of these channels is overtaxed by the quick delivery of the water from all parts of their watersheds, and the result is that the channels are greatly enlarged by the erosive action of the water. This enlargement continues until huge gullies are formed, often 15 to 20 or more feet deep. The enlargement due to ditch erosion is very rapid on the upper parts of the watershed, where the slopes are comparatively steep. Ditch erosion generally decreases downstream as the fall of the channel becomes less, and the fall often becomes so slight that silting occurs instead of erosion, particularly where the channel extends across a wide bottom and discharges into another stream.



B. P. R. D2234

FIG. 4.—Part of cornfield covered with sand washed from hillside gullies, the result of one heavy rain. Near Jackson, Tenn.

WATERFALL EROSION.

Waterfall erosion, which is responsible for many of the deepest gullies or chasms, is caused by the falling of water over the edge of a bank of a gully or ditch. The edge is washed away and caves in, owing to the undermining action of the falling water, and the waterfall moves back upstream. The undermining goes on rapidly when sand or easily eroded subsoil saturated with seepage water

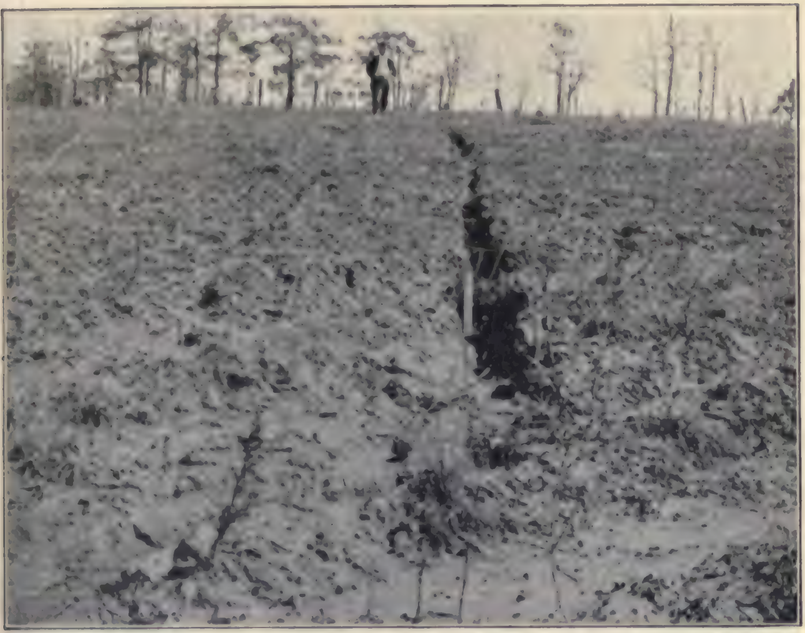


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FIG. 5.—The beginning of a gully down a hillside caused by the passing of a wagon once down the slope, if not controlled, destined soon to be a large gully. Near Jackson, Tenn.

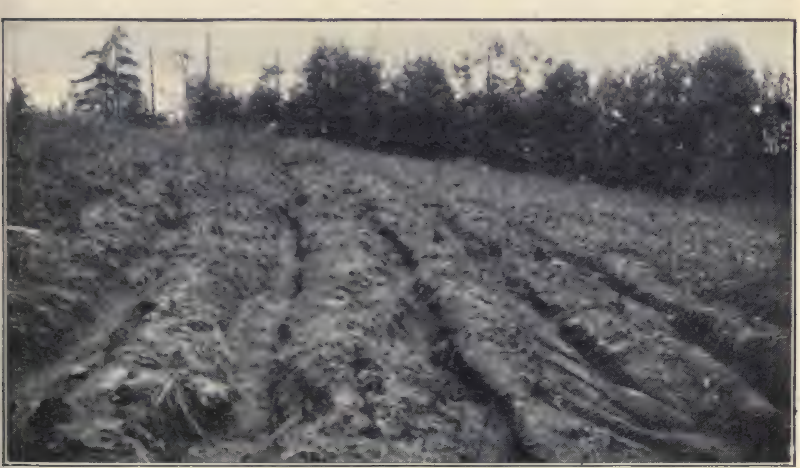

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FIG. 6.—Gullies on a hillside due to running cotton rows directly up and down the slope. Near Jackson, Tenn.

underlies the surface soil. These gullies often start in the banks of natural watercourses which have been eroded to a great depth. They extend back into the land slopes and grow deeper up the slope, often attaining depths of 50 to 60 feet. As they extend backward and cross tributary watercourses or natural depressions, waterfalls are in turn formed in their sides and branch gullies develop (fig. 7). This branching may continue until a network of gullies covers the entire watershed. Gullies formed by waterfall erosion may extend back through almost level land. Their growth is dependent upon the size of the drainage area furnishing water and not upon the slope of the land. They sometimes grow at the rate of 30 to 50 feet in a year, depending upon the amount of rainfall and the drainage area.

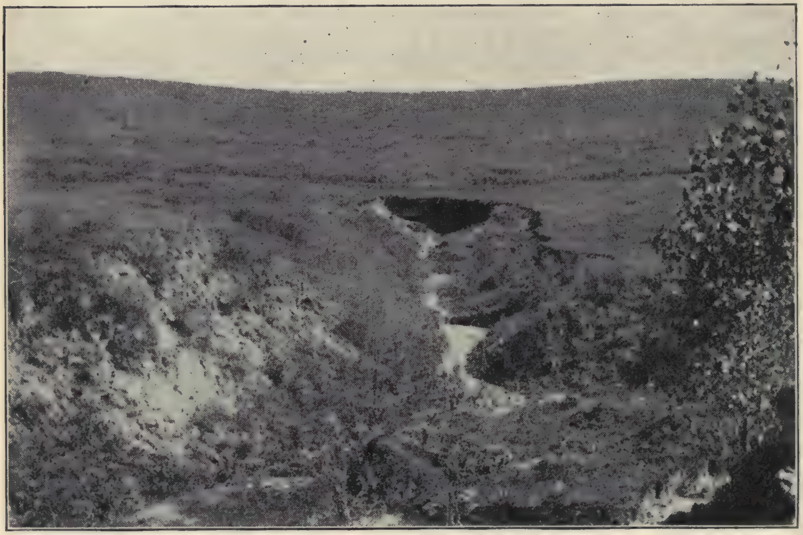

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FIG. 7.—Gully branching off from main gully and advancing up a hillside, growing in depth as it eats its way. Note the undermining of the bank at its head. Near Alma, Wis.

EROSION BY FREEZING AND THAWING.

Another type of erosion, common throughout the South, is caused by alternate freezing and thawing followed by heavy rains. It works on all slopes of a gully bank and does not necessarily follow watercourses. Owing to its capacity to extend in all directions, erosion of this type expands over wide areas, its direction of growth not being dependent upon the slopes of a field. It progresses rapidly, particularly in light silty or sandy soils (fig. 8).

PREVENTION OF GULLYING.

If the farmer could have foreseen the results of failing to spend an hour or two in checking the beginning of a gully such as is started from a wagon track down a hillside, many of our largest gullies would never have been formed. A stitch in time saves many times nine. Gullies from head erosion could be prevented if each square foot of the field slopes could be made to absorb all of the rain that falls upon it. The water would then be fed slowly to the main watercourse below, thus precluding the formation of a deep gully with its numerous deep branches of the waterfall type. Means employed to this end are: increasing the humus content of the soil, deep plowing, the use of cover crops, proper crop rotation, contour plowing, and tile draining.

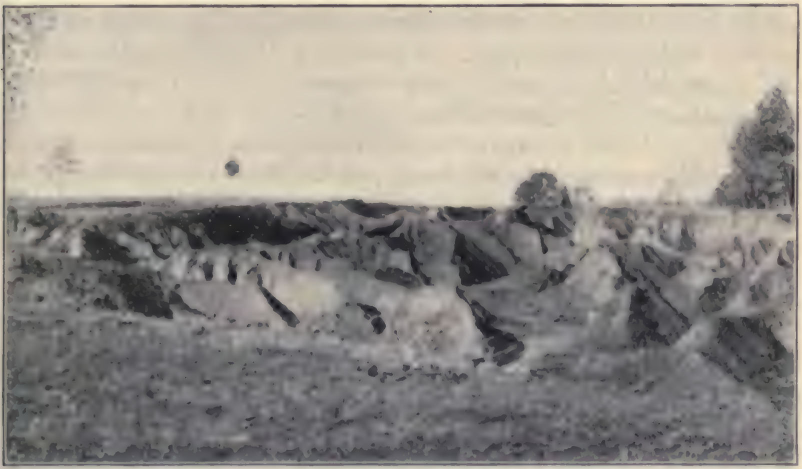

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FIG. 8.—Gullied area on moderate slope growing larger each year. A type of gullying due largely to freezing and thawing followed by heavy rains. Near Middletown, Tenn.

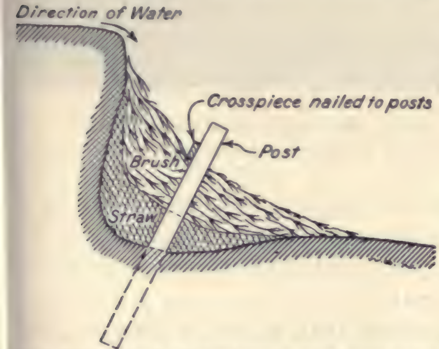

FIG. 9.—Method of checking erosion and undermining at the head of a gulley by brush and straw held firmly in place.[1]

It is, of course, impossible to make any soil absorb all the water from the heaviest rains, and in order to prevent erosion the excess water should be conducted from the field at a low velocity. This can be most effectively done by terracing the land. Farmers' Bulletin 997 covers in detail the practice of terracing farm lands.

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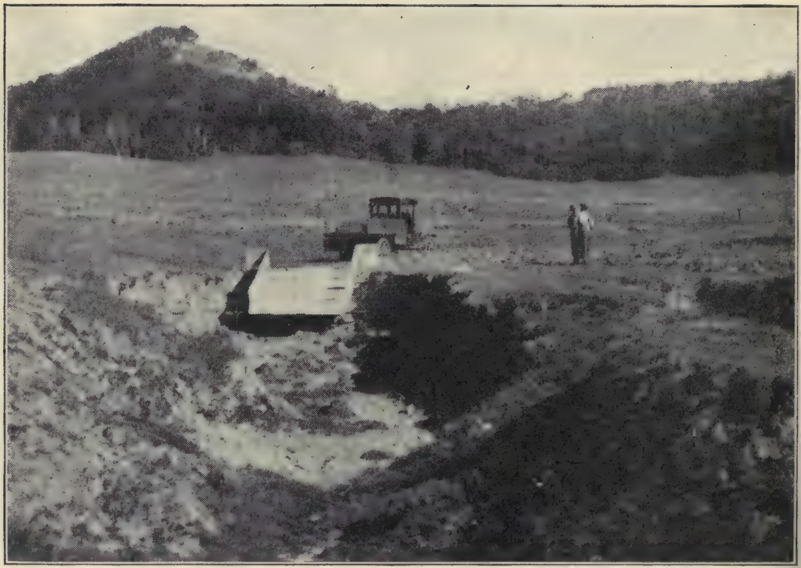
[1] From Bul. 74 of the Iowa State College Agr. Ext. Dept.

CHECKING HEAD EROSION.

No matter what method is adopted for control and reclamation of a gully, it is first of all important that erosion at the head of the gully be checked. Where possible it is advisable to intercept the water before it enters at the head of the gully and divert it into a natural watercourse nearby. In shallow gullies, 3 or 4 feet deep at the upper end, head erosion can be checked quickly by building a low obstruction or dam close to the head of the gully. A fill of soil will occur between the dam and the head of the gully, the drop of the water will be reduced by the height of the dam, and the erosive and undermining action of the water will be greatly decreased at the head of the gully. If the gully is deep, a comparatively longer time will be required to fill it, whatever method is employed, and during the filling some temporary means should be employed to stop erosion and undermining at the head of the gully.



B. P. R. D-3853

FIG. 10.—Water conducted into head of gully by levee and a sheet metal flume, the left-hand levee not yet built; brush and stone to be placed at the lower end of the flume. Near Alma, Wis.

A method of checking head erosion that is widely used in Iowa consists in placing brush and straw in the head of the gully and fastening it down as shown in figure 9. Posts should be set deep in the ground, close to the bank of the gully, and 2 to 3 feet apart. Fence posts can be used for this purpose. A layer of straw is first thoroughly packed around the posts and against the eroded and undermined part of the gully bank. A few branches are laid crosswise and interwoven between the posts to hold the straw in place.

Brush is packed down over the straw, the tops of the branches extending nearly to the top of the gully bank, and is held in place by the crosspiece nailed to the post as shown in figure 9. This affords a place for the water to fall without causing erosion and stops the progress of the gully by preventing undermining until the gully is filled by other methods.

In figure 10 is shown a sheet-metal flume at the head of a gully. The water is conducted into the flume between earth dykes. This flume is intended for use until the gully can be filled by means of dams constructed below. Some sort of protection is generally required at the lower end of the flume to prevent washing.

NATURAL CONTROL AND RECLAMATION.

Nature's method of controlling gullies is to prevent erosion on the surface by the growth of vegetation and to hold the soil together by the plant-root systems. The dead organic matter which accumulates on the surface of the soil from year to year prevents surface erosion and absorbs much of the rainfall. Nature can control gullies, but the natural process of reclaiming them after they are formed is very slow.

After eroded and badly gullied land has been abandoned a volunteer growth of some sort usually springs up. The kind of growth depends upon the locality. Wild native grasses, weeds, shrubs, and trees are the most thrifty and best for rapid and permanent control of the gullies. In some sections pine trees spring up spontaneously over eroded areas and in conjunction with weeds and grasses form a good natural control. Wild honeysuckle grows and spreads rapidly on poor soils and is one of the most effective plants of natural growth in controlling erosion. On account of its tendency to spread, however, other plants are preferred by some farmers. Large gullies with steep caving banks are the most difficult to control by natural means. Their erosion generally continues for many years after the land has been abandoned. Large trees figure prominently in the control of such gullies. The best natural control is where soil is supplied with both nitrogen and humus by the plant growth, so that if the land is ever reclaimed for agriculture it will possess the essential elements of fertility. The black locust and sweet clover furnish nitrogen to the soil and have large, branching root systems, efficacious factors in the control and reclamation of gullies.

In Pendleton County, Ky., large eroded areas of abandoned lands have been reclaimed by the volunteer growth of sweet clover. When sweet clover made its first appearance in the county it was regarded as a weed of the worst kind because of its big root system and prolific growth. Many farmers who formerly devoted much time to ridding their places of this plant now gather the seed and sow it on their worn-out gullied lands, having noted the large crops grown on abandoned lands reclaimed by the volunteer growth of sweet clover. Sweet clover[1] is a biennial plant. A large root is formed the first year, from which springs the second year's growth. In the second year the plant goes to seed and the root dies. The plant thus reseeds itself, and the decayed roots furnish nitrogen and humus to the soil in addition to making the soil more permeable. Sweet clover is a profitable crop, as it makes excellent hay and furnishes good pasture. It grows well in both Northern and Southern States, but requires a certain amount of lime for rapid and luxuriant growth. Its remarkable growth in Pendleton County can be attributed largely to the plentiful supply of lime available in the soil.

PLOWING-IN AND SEEDING GULLIES.

Plowing-in and seeding is a simple though sometimes rather expensive method of reclaiming gullies. It is applicable to both large and small gullies with small drainage areas and has been successful in all sections of the United States.

In the reclamation of a gullied hillside where gullies are small (1 to 3 feet deep) and have no well-defined drainage areas they should be entirely filled. They can be first partly filled with manure, straw, corn stalks, or small brush, which should be covered with a foot or more of dirt by plowing and scraping in the edges of the gullies. If it is not desired to cultivate the hillside, erosion may be largely prevented by seeding and keeping the land in meadow or pasture, or by devoting it to the growth of timber. If the land is to be cultivated it should first be terraced.

For shallow gullies, or deep gullies with gently sloping banks, the plowing is begun in the bottom of the gully or as near the bottom as possible. The dirt is thrown toward the center of the gully from both sides. The plowing is done in the same way as in breaking land and is continued a few furrows beyond both edges of the gully. To push the dirt toward the center of the gully, an ordinary road drag or steel ditcher can be used to advantage after each furrow. If the upper part of the side slope is steep it is cut down and rounded off with a mattock. In case sufficient dirt has not been moved into the gully after the first plowing, the plowing may be repeated until the desired filling is obtained. If the side slopes are too steep for a team to walk on, a chain hitch to the plow should be made, which will permit plowing on the slope when the team is on the edge of the gully.

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[1] For information on sweet clover see Farmers' Bulletins 485 and 820.

In plowing-in a deep gully with nearly vertical banks the team is made to walk as close to the edge of the gully as possible, and the upper edge of the bank is plowed into the gully. The second furrow cuts the first deeper and the third takes another slice below the second. A long chain is attached to the plow so that it can be operated down in the gully while the team walks along the upper edge.

After the first line of furrows has reached as far down as the plow can be operated, the process is repeated by starting at the top again, the object being to reduce the side slope of the gully. If the gully be not too deep the side slopes can be so reduced in a short time that the team can walk up and down the slopes and across the gully. The team and a scraper can then be used further to reduce the side slopes and distribute part of the soil over the bottom of the gully, or the method described for gullies with gently sloping banks can be employed.

The freshly plowed earth over the sides and bottom of the gully affords a good seed bed for plant growth. Grasses should be sowed or trees planted to hold the soil in place, and temporary dams of some material such as brush or straw should be built to catch the loose soil that might otherwise be washed away by heavy rains. Some of the grasses that can be used for this purpose are Bermuda grass, orchard grass, blue grass, redtop, sweet clover, and lespedeza. Every locality has certain grasses best suited to it. Bermuda is probably one of the best grasses for southern conditions, and it provides excellent pasture for stock. Wild honeysuckle grows luxuriantly in the South on almost barren soils. A more rapid growth can be obtained in gullies by applying elements of fertility in which the soil is deficient. Manure will supply the required elements in most soils. Sorghum is very effective in controlling erosion in gullies.

On the State agricultural experiment station farm near Holly Springs, Miss., some very badly gullied lands were reclaimed by the plowing-in and filling method. Gullied areas of the type shown in figure 8 were reclaimed on this farm. The filled-in gullies were seeded to lespedeza or to Bermuda grass. Most of the land was then terraced so as to keep the water from flowing down through the gullies. In some instances, on this farm and others, dynamite was used to advantage in leveling down and filling gullies. The banks were broken down and blown into the ditch by placing explosives in a row of holes 2 to 4 feet from the edge of the gully, depending upon its depth, or in a row of horizontal holes in the sides nd near the bottom of the gully. The first method is preferable or gullies with broad, sloping banks and the second for gullies with high, steep banks.

TILING AND PLOWING-IN GULLIES.

In connection with plowing-in, further erosion is sometimes prevented in a gully by the use of tile. Large tile, the size depending upon the area drained by the gully, is laid down the middle of the gully. The water may be conducted into the tile from a catch basin at the upper end of the gully or by building a dam across the gully and extending the tile through the dam.

PLANTING TREES TO CONTROL GULLYING.

In many localities gullying has been effectively checked by the planting of trees. This method is particularly adapted to land that is very steep or that has been gullied so badly that the cost of reclaiming it for pasture or cultivation would be prohibitive. In addition to building up the land the wood lot thus formed may be made a paying investment to the farmer, furnishing firewood and small timbers. In the South the black locust is an excellent tree for this use. North of the Kansas-Nebraska line it is very commonly attacked and destroyed by the locust borer. The black locust is a legume, and builds up soil by contributing nitrogen. It has a large interlacing root system which holds the soil particles together and prevents washing. It grows to the size of a good fence post in about 10 years, and is especially adapted for posts on account of the durability of its wood. Other trees[1] that are used in different sections for planting on eroded areas are pine, catalpa, yellow poplar (tulip), walnut, and red and black oak.

In planting trees on gullied and eroded areas the best results are obtained by plowing the entire gully and thoroughly disking or harrowing the ground. The trees should be set out in rows 5 to 6 feet apart in deeply plowed furrows. The rows on the sides of the gully should be laid out approximately on the level, as the trees should be cultivated the first year by throwing the dirt from each side toward the trees. Less washing occurs where the rows closely follow the contour of the ground. It is very important that the soil bed be properly prepared, as this will promote a rapid growth of the trees, and the trees are less likely to die at the start.

The best results are obtained where some kind of dam is built across the gully to catch and hold any soil that otherwise would be carried away in the drainage water. Brush dams are commonly used for this purpose; before they rot out the tree root systems will have extended so as to prevent serious washing (fig. 11). It is also a good plan to sow grass seed between the trees after setting them out. This grass should not be pastured, or at least close pasturing should be avoided, as it greatly retards reclamation. Where a thicket of locust is desired and not much importance is attached to the use of the trees for posts the tress are sometimes cut down after the first year; this results in sprouts springing up between the tree rows. A dense growth results, which is more effective in checking erosion.

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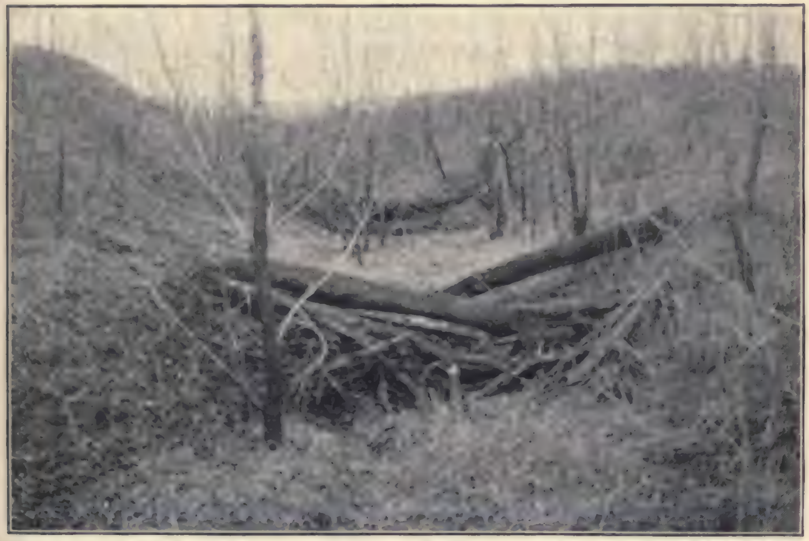
[1] For a list of trees adapted for use in the various sections of the United States the reader is referred to Farmers' Bulletin 711, "Care and Improvement of the Wood Lot."

In many instances willows have proved effective in checking erosion in a gully. They should be set out at intervals in rows across the gully. For rapid growth, however, they depend upon an abundance of water.[1]



B. P. R. D-3968

FIG. 11.—Gully formerly deep with steep banks reclaimed by locust trees and brush dams. Near Martin, Tenn.

SOIL-SAVING DAMS FOR GULLIES.

The most common method of controlling or filling in and reclaiming gullies consists in building soil-saving dams across the gullies.

Dams may be built of a variety of materials. Temporary dams are built of stakes, brush, straw, logs, loose rock, or woven wire, while permanent dams are built of earth, masonry, or concrete. The cost of building dams is often very little where use is made of material available on the farm. Stones are a nuisance in a field, but they are excellent material for dams. Where no stones are available timber and brush may be plentiful and log and brush dams may be built at small expense. Where none of the above materials is available straw may be abundant and can be employed with stakes to build low dams. Woven-wire fencing can be obtained at small cost in any locality and is an excellent material for low dams.

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[1] For information on setting out and caring for trees the reader is referred to publications of the Forest Service, U. S. Department of Agriculture.

Most temporary dams are porous; that is, when first built they permit the water and part of the silt to pass through them. They are gradually built up by the filling of the pore spaces with trash and soil brought down by the water and are never subjected to the heavy pressure exerted on a water-tight dam from the water ponded above.

Most permanent dams are water-tight, and in order to pass from the upper to the lower side of the dam the water must either flow over or be diverted around the dam or be carried through it by a conduit. If the water is to be permitted to flow over the dam, a spillway of nonerosible material is provided, generally at the middle of the dam, and it should be wide and deep enough to remove the greatest flow of water expected. If the water is to be diverted around the ends of the dam, it is generally made to flow over firm, sodded ground. Sometimes a shallow channel is dug for carrying the water around the end of the dam and emptying it into the gully at a considerable distance below. If the water is to be passed through the dam, it is carried in a pipe.

The inlet consists of a vertical pipe connected to a horizontal line of pipe extending through the dam along the bottom of the gully. The top of the inlet is lower than the top of the dam and the water ponded above the dam does not flow out until it reaches the level of the top of the inlet pipe. The pond above the dam practically forms a sedimentation basin, as the silt in the water settles to the bottom of the pond and in time fills the gully to the top of the inlet pipe. A dam of this kind is sometimes called the drop-inlet soil-saving dam, from its vertical inlet pipe. It is known throughout the State of Missouri as the Adams soil-saving dam, as it is said to have been originated more than 30 years ago by J. A. Adams, a pioneer farmer of Johnson County, Mo. Mr. Adams has five of these dams on his farm, all of which have successfully filled and reclaimed gullies.

LOOSE-STRAW DAM.

In some localities it is not unusual to see a stack of straw forming a dam across a deep, wide gully. Where the threshing of grain is done near a large gully the straw can be placed directly in the gully by the machine. This method is very successful for large gullies with very small drainage areas and little fall. Where considerable water flows through a gully the straw dam is likely to be washed out or a channel washed around the end of the dam. The chances of failure can be reduced by building the dam high at the sides and low in the middle, so that if all the water does not seep through the straw it will flow over the top of the dam at the middle.

The first straw dam should be built near the mouth of the gully so as to catch all the soil that is being carried away by the water. At the same time provision should be made to stop waterfall erosion at the head of the gully. After as much soil has been filled in above the first dam as it is thought can be held by the sod seeded there when the straw rots out, another straw dam should be built farther up the gully a short distance, and then another until the gully is filled in as desired.

This is a simple and easy method of reclaiming certain types of gullies, but it depends on the availability of a large quantity of straw. With more time and labor to be devoted to the work a more economical use can be made of the straw in building brush, straw, and stake dams, as described later.

Further washing of small shallow gullies is sometimes prevented by filling them with loose straw during the fall and winter. The water percolates through the straw, the silt in the water being retained. In the following spring the partly rotted straw is generally covered by plowing-in the gullies, thus adding to the fertility, and increasing the humus content and the absorptive capacity of the soil. On steep slopes or where the quantity of water reaching the gullies is large, this method is not a success, since the straw is usually carried to the foot of the slope by the force of the water.

WOODEN-STAKE DAM.

A cheap method of filling-in and reclaiming gullies of moderate slopes and small drainage areas consists in driving several rows of stakes across the gully in checkerboard fashion. The stakes should be 3 to 7 feet long with a diameter of 2 to 4 inches at the upper end. The distance between the rows of stakes should be from 6 inches to 2 feet, and the distance between the stakes in the rows, the same. The stakes should be driven into the ground until the tops extend 8 to 20 inches above the surface; the larger and longer the stake the greater may be the distance between the rows and stakes. The rows of stakes should extend across the gully and up the sides as high as water ever reaches in the gully, and the height of the tops of the stakes on the sides of the gully should be at least 1 foot higher than the tops of the stakes in the middle. The stakes may be made of any available hard wood. Where stones are available the dam can be made more substantial by filling in the spaces between the stakes with them, as shown in the three lower dams in figure 12.

Where stone is not available the ability of the stakes to check and hold silt can be increased by filling in straw between them. A series of such dams should be built along the entire length of the gully, the distance between them being such that each dam will cause a deposit of silt extending to the next above. As soon as the filling in above the first series of dams is completed other dams should be built between the first ones and the filling-in process continued by additional dams until the gully is filled as desired.

BRUSH DAM.

In localities where timber and brush are abundant excellent results have been obtained by the use of brush dams. The methods employed in building these dams vary somewhat in different sections of the country. In hillside gullies where the flow of water is small the dams are commonly built of loose brush sometimes weighted down with logs. Where the flow is sufficient to overtop the dam the brush can be held down by crosspieces and stakes, or the dams are sometimes built by weaving brush into a row of stakes across the gully. Successful results can not be obtained by simply dumping the brush into the gully.

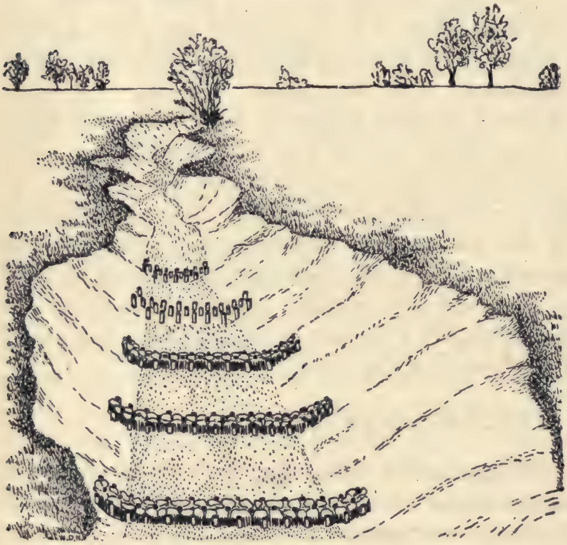

FIG. 12.—A series of stake dams in a gully. The spaces between the stakes in the three lower dams are filled with stones.

In connection with reforestation of gullied lands in Tennessee the State forester, R. S. Maddox, has used loose-brush dams extensively. The dams are built to catch and hold soil in the gullies until the planted trees are able to hold the soil against erosion.

The method of Mr. Maddox is as follows: Trees are first dragged to the site of the gullies, and the branches are cut off. Several layers of branches with the tops pointing downstream are first laid for the foundation of the dam. This is to prevent slipping, as the greater part of the dam is built with the branches extending crosswise of the gully. The dam is built up by laying the branches close together across the gully, but occasionally a layer of branches is placed with the tops pointing upstream and extending beyond the face. When these branches become covered with silt they tend to hold the dam more securely in place and tie the brush together. After the dam is built about 3 feet high, logs furnished by the trunks of the trees are laid across on top of the brush lengthwise of the dam to hold it down. The dams are built lower in the middle so that the water will flow over the middle of the dam and prevent washing around the ends. Dams built in this manner can be used only where the drainage area of the gully is very small; where there is a large flow of water they are likely to be floated away or washed out (fig. 11).

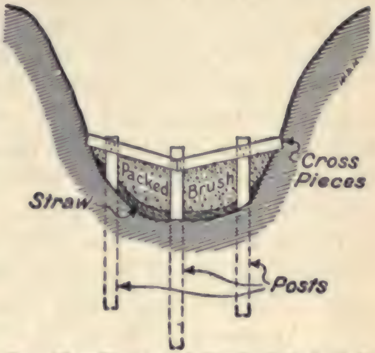

FIG. 13.—Straw and brush dam held in place by the crosspieces and posts.[1]

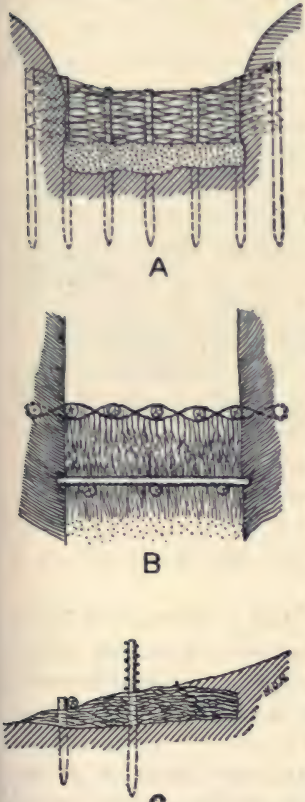

FIG. 14.—A woven-willow brush dam. *A*, Front view. *B*, Top view. *C*, Side view.

Where the water in a gully is sufficient to overtop a brush dam it is necessary to anchor the dam more securely. M. H. Hoffman and A. W. Turner, of the Iowa State College extension department, who have had a wide experience in building brush dams, recommend the following method for building brush dams that are at times overflowed: The bottom and sides of the gully for a distance of 4 to 10 feet are covered with a layer of straw that will be from 4 to 6 inches deep after being pressed down by the weight of the dam. The brush, with the butts pointing upstream, is laid close together on the straw and thoroughly tramped down, the fine brush being placed at the bottom and the coarser on top. The packed brush is held in place by crosspieces nailed to fence posts set in the line of the dam across the gully, as shown in figure 13. It is important that the fence posts be well set in the ground, usually not less than 4 feet deep. The figure shows the middle of the dam lower than the sides so that the water will not have a tendency to wash around the ends.

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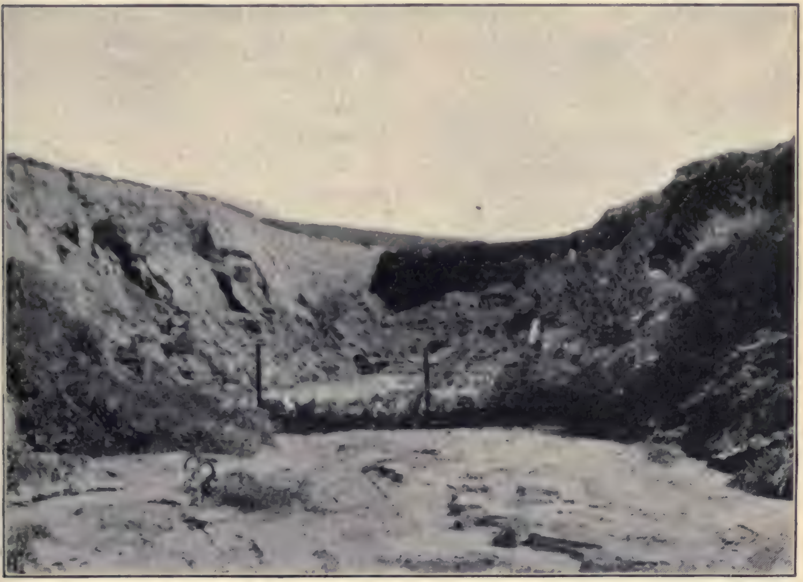
[1] From Bul. 77 of the Iowa State College Agr. Ext. Dept.

In Europe woven-willow dams, sometimes called wattled dams, are rather common and have proved very satisfactory. Live willow stakes about 3 or 4 inches in diameter and 3 to 5 feet long are driven in a row across the gully about 6 inches apart so that the tops are about 1½ feet above the ground. The row of stakes should extend as far up the sides of the gully as the highest water, and the middle of the dam should be lower than the sides. The stakes are held together by weaving willow branches between them from top to bottom. As shown in figure 14, a brush apron is made below the dam to prevent underwashing by the water flowing over the dam. This apron is built of branches 6 to 8 feet long laid lengthwise of the gully in a trench about half a foot deep. The butts of the branches are laid upstream and are partly buried in the bottom of the gully, and the downstream ends of the branches are held down by a pole laid across them and spiked to a second row of stakes about 3 feet from the first row. The wattled dam is used to some extent in this country. Pine branches are sometimes used in place of willows.

Another form of brush dam, very common in Europe, is the fascine dam. It is made of bundles of brushwood 8 inches to 2 feet in diameter and from 7 to 14 feet long. The bundles are tied together in several places with wire. They are laid with their length across the gully and rest against a row of posts set about 3 feet apart. The posts are of the size of ordinary fence posts and are driven or set into the ground at least 4 feet. The bundles are held in place by driving stakes through their centers 1 to 2 feet apart. Trenches are dug into the sides of the gully, and the ends of the bundles are extended into them to prevent washing around the ends of the dam. The top of the dam is made lower in the middle, and an apron of brush to prevent undermining is built below the dam in the manner described for the woven-brush dam. The height of the dam at the middle is 1½ to 2½ feet.

The brush dam is cheap and easy to build and is effective in filling gullies when carefully and properly constructed. For this reason it is popular among farmers and is employed to some extent in every section of the United States where timber is available. It is best suited for gullies with small drainage areas.

When a farmer has a large quantity of brush to dispose of, a very common practice is to fill large, deep gullies for their whole length with brush which is thoroughly tramped down. When the whole gully is filled it is practically impossible for the force of the water to move the brush and the silt is caught and held by the brush as the water flows through. Sometimes sections 20 to 50 feet in length are filled solid with brush at intervals along the gully. The huge dams of brush eventually cause the filling of the gully between. Another practice is to shingle the bottom of the gully with brush (as the roof of a house is shingled), commencing at the lower end of the gully and laying the brush with the tops pointing upstream. If the water is likely to displace the brush it can be held in place by crosspieces fastened to stakes at intervals along the gully. Leaves scattered over the brush assist the catching of silt. After the first layer of brush is covered with silt, other layers can be placed on top until the gully is filled. This practice is especially applicable for filling the lower end of a gully where the fall is not great.



B. P. R. D-3248

FIG. 15.—Newly constructed woven wire fencing dam built to control erosion at head of gully. Near Alma, Wis.

WOVEN-WIRE DAM.

It is common to see drift and silt collected above a woven-wire fence that extends across a draw in a field. In this way, perhaps, the idea of the woven-wire dam originated. Like the brush dam, the woven-wire dam is found in every section of the United States.

A woven-wire dam consists essentially of a low fence across a gully, the difference being that the posts must be set closer together and anchored solidly upstream where the force of the water is great. The common method of building these dams consists in setting a row of ordinary fence posts across the gully about 4 feet apart. The posts should be set at least 4 feet deep and should be anchored by wire to anchor posts driven 8 or 10 feet above the line of the dam. These anchor posts are later covered with the deposit of soil caught by the dam, which greatly increases their holding power. The end posts should be set in a trench dug into the sides of the gully. The best results are obtained when a trench is dug along the upper side of the posts so that the woven wire may be fastened 6 inches or a a foot below the surface. The woven wire should be at least 30 to 36 inches wide and should be set into the ground so that about 2 feet extend above the surface. The wire is fastened to the upper sides of the posts, and the trench in the sides and across the gully is filled up and carefully tamped. When there is not enough trash in the water to close the large meshes in the wire and catch the soil particles, a little straw, leaves, or fine brush can be placed against the upper side of the wire to get a fill started. Angle-iron posts are sometimes used instead of wooden posts (see fig. 15).

A dam of this type is especially suitable for use in gullies with moderate slopes and small drainage areas. It is very effective in checking head erosion at the upper end of the gully.

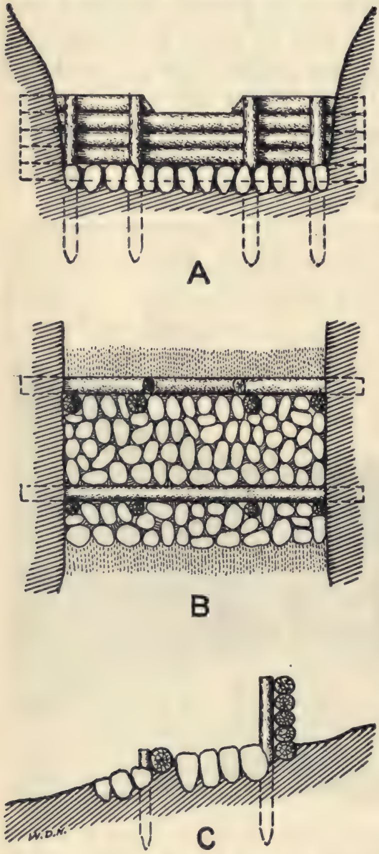


FIG. 16.—Dam built of logs and posts with spillway at center and stone pavement below the dam. *A*, Front view. *B*, Top view. *C*, Side view.

LOG DAM.

In a country where timber is abundant log dams are very commonly built to check gully erosion. The simplest dam for small, narrow gullies is made by placing a large log in a shallow trench across the gully. The trench is cut into the sides of the gully so that the ends of the log extend into both sides. Other smaller timbers about 6 or 8 feet long are laid close together lengthwise of the gully, with the downstream ends resting on the log and the other ends on the bottom of the gully above the log. The timbers are spiked to the log. Old railroad ties are sometimes used for the timbers. Dams built in this manner have been very successful in filling gullies draining small areas.

Another type of log dam rather simple to construct is built as follows: Posts are set in a row across the gully 4 feet apart, about 4 feet deep, their tops extending 3 or 4 feet above the bottom of the gully. A trench is then dug on the upstream side of the posts extending about 2 feet into the sides of the gully. A log is laid in this trench, which is just about deep enough to bury the log, and other logs are laid on top of the first, until the top log is as high as the top of the posts. The logs are held in place by piling dirt against them or by driving small stakes on the upper side at the ends of the logs, or they are spiked to the posts. A section of the top log between the two posts nearest the center of the dam is cut out to provide a way for the water to flow over the dam and prevent washing around the ends (fig. 16). The bottom of the gully should be paved with stone for a distance of about 4 feet below the dam, or it may be protected from erosion by laying small logs together as a floor, holding them in place by stakes driven along the lower side. Where rock is plentiful loose rock is placed below the dam to prevent erosion by the falling water. Unless one of the above methods is employed there is likelihood of undermining the dam.

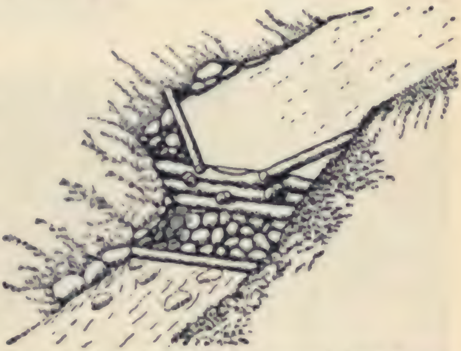


FIG. 17.—Log dam held by notched logs extending obliquely into the sides of the gully.

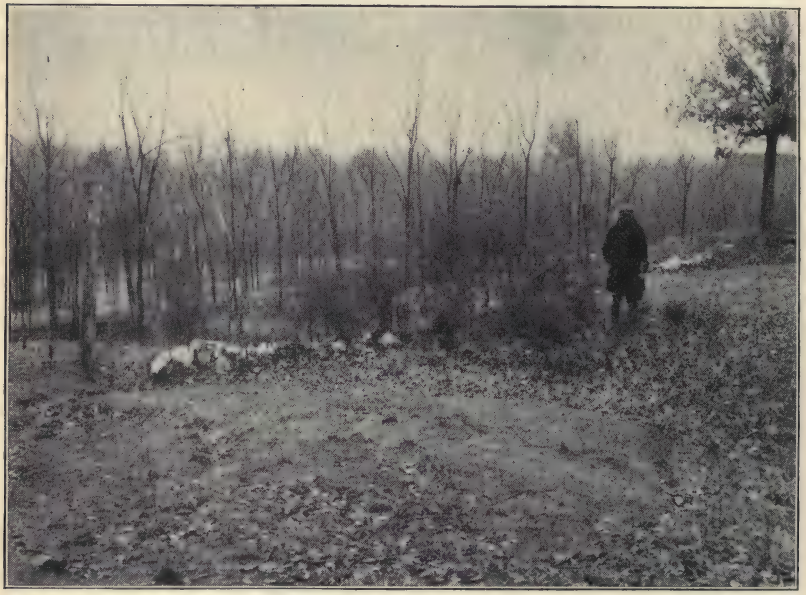
Where it is difficult to drive or set posts in a gully the logs may be held in place by other logs laid obliquely across them with the ends notched to fit into corresponding notches between the logs of the dam. The free ends of the oblique logs are covered with dirt, and their hold becomes stronger as the fill above the dam increases in depth (fig 17).

Where both timber and stone are plentiful, crib dams are sometimes built. The crib dam consists of a framework or box of logs across the gully, filled with rock fragments or stones. The ends extend into the sides of the gully, and the dam is built in a trench dug across the bottom. Undermining is prevented by a pavement of stone below the dam.

WILLOW-POST DAM.

Willow posts cut from green willow trees are used very effectively to fill gullies. They are set 2 or 3 feet apart in rows across the gully, sometimes several rows of them close together. Where there is plenty of water the willow posts take root and grow, forming a hedge across the gully. Trash and silt are caught above this hedge, causing a fill of soil. Straw or loose small brush may be thrown above the willows to assist in getting a fill started.

When quicker results are desired, a row of willow posts, 3 or 4 feet apart, is set across the gully, and railroad ties or logs are laid one on top of another above the posts in a manner similar to that described for log dams. Willow dams are usually built at the lower ends of gullies near main watercourses or where the soil is naturally moist throughout the year, for the rapid and thrifty growth of willows depends upon abundant water.

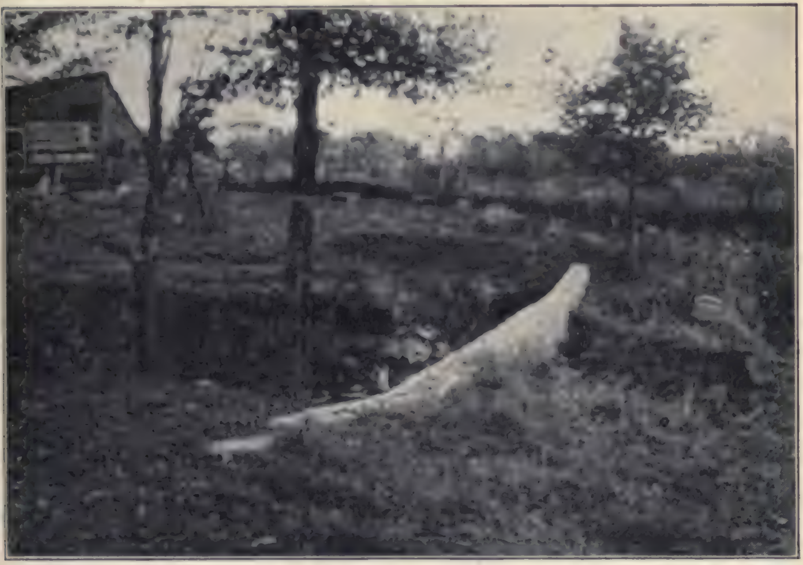


B. P. R. D-3947

FIG. 18.—Upper side of a loose rock dam across a gully. A fill of 2 feet has occurred where the man is standing. Near Franklin, Tenn.

LOOSE-ROCK DAM.

Rock is a very good material for building low soil-saving dams. Its use is particularly advisable on farms where rock is plentiful and often a nuisance in the fields. Loose-rock dams should not be more than 2 to 3 feet high and should be built only in gullies of moderate slope and small drainage areas. The dam should be 4 or 5 feet wide at the base and about 2 feet wide on top. The rock should be so arranged that the small pieces fit in among the large. Only large pieces should be used on the top of the dam, as a current of water has often sufficient force to move even large stones. The dam should be built well into the banks of the gully and should be lowest in the middle. A trench about 6 inches deep should be dug across the gully, in which the foundation of the dam, consisting of the largest rock, should be laid. The gully below the dam for about 5 feet should be covered with loose rock to prevent erosion and the undermining of the dam. Figure 18 is a view above a loose-rock dam that has caught a fill of about 2 feet.



B. P. R. D-3880

FIG. 19.—Masonry dam built across a gully draining over 1,000 acres. This dam extends well into the banks and lower in the middle than at the ends. Near Kansas City, Mo.

STONE-MASONRY DAM.

Masonry dams are usually built instead of loose-rock dams where a greater height than 3 feet is desired, where the flow in the gully is large, or where rock is not plentiful and its economical use is necessary. The construction of the dam is similar to that of a masonry wall, and the sides should have a batter of 1 in 5 or 1 in 10. The thickness of the dam at the bottom should be about one-half the height, and the base should be 1 to 2 feet below the bottom of the gully for dams 3 to 6 feet high. Dams of this kind higher than 6 feet are not recommended unless an excellent foundation be obtained, special precautions be taken against undermining, and the walls be extended far enough into the banks of the gully to prevent cutting around the ends. The services of an engineer would be required to build a high masonry dam, and hardly any two gullies would require the same design.

For dams 3 or 4 feet high the water may be made to flow over the central portion of the dam by gradually increasing the height of the dam from some point near the middle toward the ends, as shown in figure 19. Where the ends of the dam are extended well into the banks, it is not necessary for the base at the ends to be as low as the base across the gully. Loose rock should be placed below the dam to prevent washing and undermining.

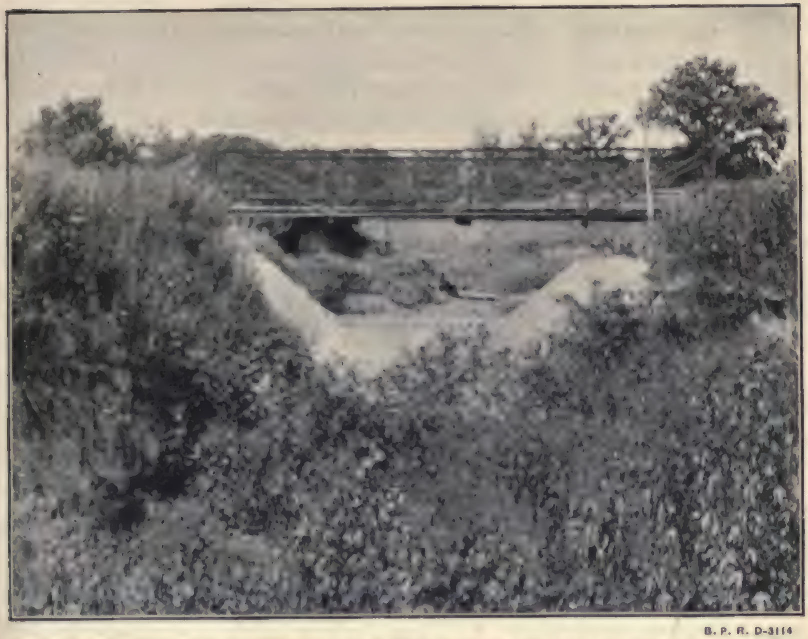
A dam higher than 4 feet should have a notched spillway in the middle that confines the overflow water to the middle portion of the dam, and a carefully paved floor should be prepared below the spillway to prevent undermining by the falling water. Masonry dams more than 3 or 4 feet high are not much used in the reclamation of gullies, owing to the high cost and the difficulty of making them secure.

CONCRETE DAM.

Concrete dams are frequently employed in all sections of the country to control and fill in gullies. It must be said that results have been generally far from satisfactory. Failures are common and may be attributed to both poor design and faulty construction, generally due to the desire to keep the cost low, or to inadequate conceptions of the erosive action of moving water and the pressure exerted by standing water. Where concrete dams have been properly designed and constructed good results have been obtained.

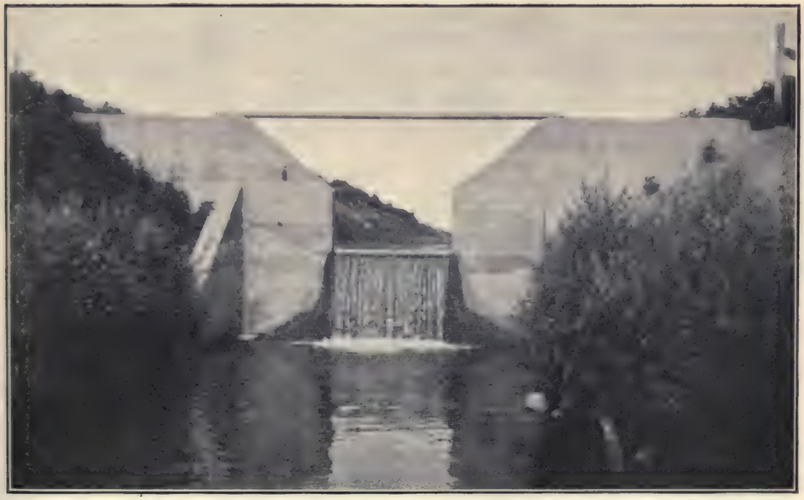
In building concrete dams provision should be made for passing the water over the dam, without injury to the structure, by providing for a spillway, usually over the middle of the dam. If the dam is level on top, with no spillway, the water flowing over the entire dam will invariably cut the earth away around one or both ends, and a channel will be formed for the passage of the water around the end of the dam, which will also allow the accumulated silt to escape. In conjunction with the spillway the sides should extend to the top of the gully or as high as it is expected that the water will rise in the gully, so that the water can not come in contact with the sides of the gully (fig. 20). The ends of the dam should extend far enough into the sides of the gully to prevent seeping of water around the ends, which often results in a washout.

In figure 21 is shown a properly designed reinforced concrete dam with spillway, suitable for gullies draining large areas. The abutments extend well into the banks as high as the top of the ditch. The buttresses, one on each side of the spillway, give support to the dam and confine the water so that it falls on a concrete floor ex-



B. P. R. D-3114

FIG. 20.—Concrete dam across large gully with sides of spillway extending to top of the banks of the gully. This dam was built to fill the gully and prevent enlargement where the highway bridge crosses. A fill of 8 feet has occurred above the dam. Near Mason City, Ill.



B. P. R. D-4125

FIG. 21.—Reinforced concrete dam with spillway and concrete apron below, suitable for use in gullies that drain large areas. Cerro Gordo County, Iowa.

tending between and to the ends of the buttresses. Thus overturning and undermining, which are common causes of failure, are prevented. A dam such as is shown in figure 21 is only intended to fill the gully to the crest of the spillway; the height to which the spillway can be built depends upon the flow of water in the gully. If the fill in the gully is made too deep there is danger of the water overtopping the banks of the gully and the entire dam.

In figure 22 are shown the plan, elevation, and side view of a reinforced concrete dam recommended by the agricultural extension department of the Iowa State College. It is claimed for this dam that "it has a firm foundation, extends well into the banks, has an adequate spill platform, is built with the water, and has a means of relieving the water pressure." This design was proposed by the extension department after making comprehensive investigations of concrete dam failures throughout the State of Iowa, and it especially guards against the common causes of failure.

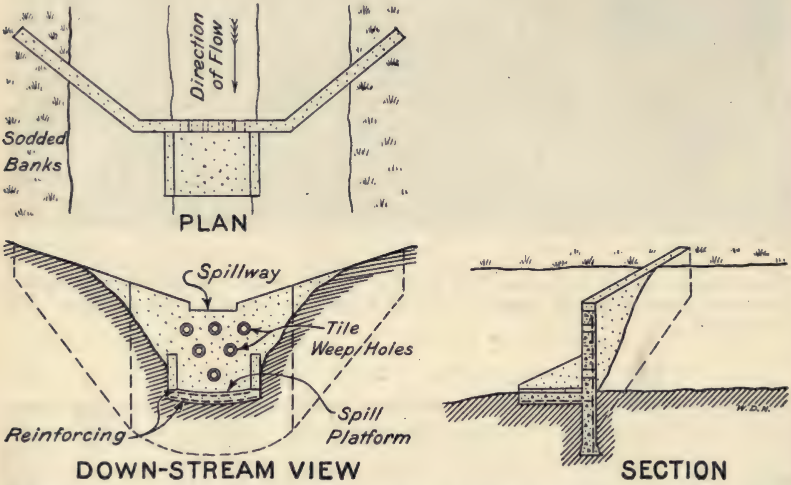


Fig. 22.—Plan, section, and downstream view of a concrete dam especially designed to guard against the common causes of failure.[1]

Concrete dams are built of either plain or reinforced concrete. Dams not exceeding 3 or 4 feet in height are usually built of plain concrete and higher ones of reinforced concrete. Failures often occur as a result of poorly made concrete. A good concrete mixture is 1 part cement, 3 parts sand, and 6 parts stone or broken rock. The services of a competent engineer should be engaged for the design and construction of a reinforced concrete dam. No one design could be given that is applicable to all conditions.

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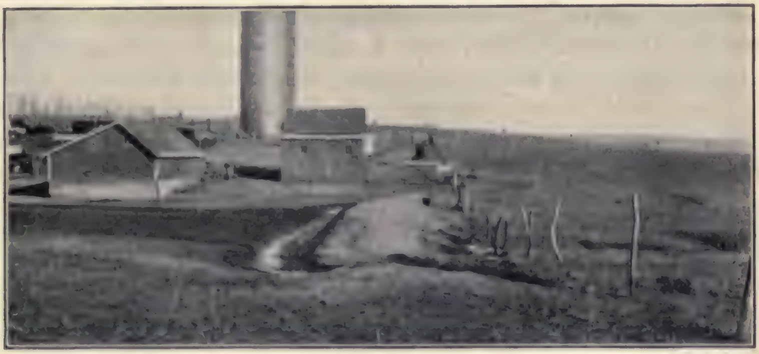
[1] From Bul. 80 of the Iowa State College Agr. Ext. Dept.

EARTH DAM.

Earth dams of two different types are used. In one type the surplus water is carried around or over the dam by spillways, and in the other it is carried through the dam by a pipe. In many installations the principles of both types are employed. Earth soil-saving dams are generally employed to fill very large gullies, though they are growing rapidly in favor for use in small gullies, particularly where no other cheap material is available for the construction of low dams.



B. P. R. D-8432

FIG. 23.—Earth soil-saving dam which has filled a deep gully. The fill is drained by a tile extending through the dam into the gully below. Near Red Oak, Iowa.

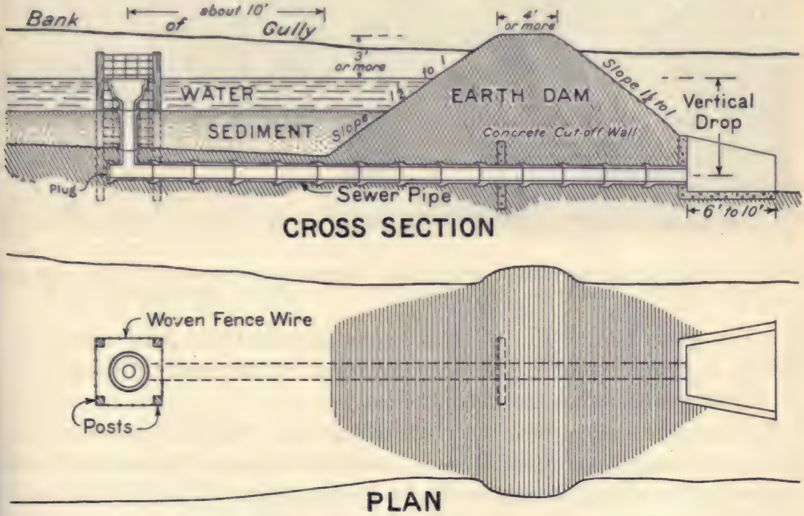


FIG. 24.—Drop-inlet and earth soil-saving dam.

If a spillway is used to carry the water around or over the dam, a pond is formed above the dam, and if the capacity of the pond is not sufficient to hold the greatest run-off of water from the drainage area the surplus water is conducted by a channel around one end of the dam, as shown in figure 23, or it may be carried over the dam in a sheet-metal or plank flume. Because of the chances of injury to the dam, the latter method is not recommended, however, unless it is impossible to carry the water around one end of the dam over firm ground. In figure 23 is shown an earth soil-saving dam that has satisfactorily filled the gully above. The gully below the dam is quite deep, and the water is kept out of it by carrying it around the dam and emptying it into a watercourse of the adjacent watershed. The fill above the dam has been drained with tile through the dam into the gully below, so that now there is good farm land where formerly a gully existed, and the advance of the gully through the farmer's barn lot has been stopped.

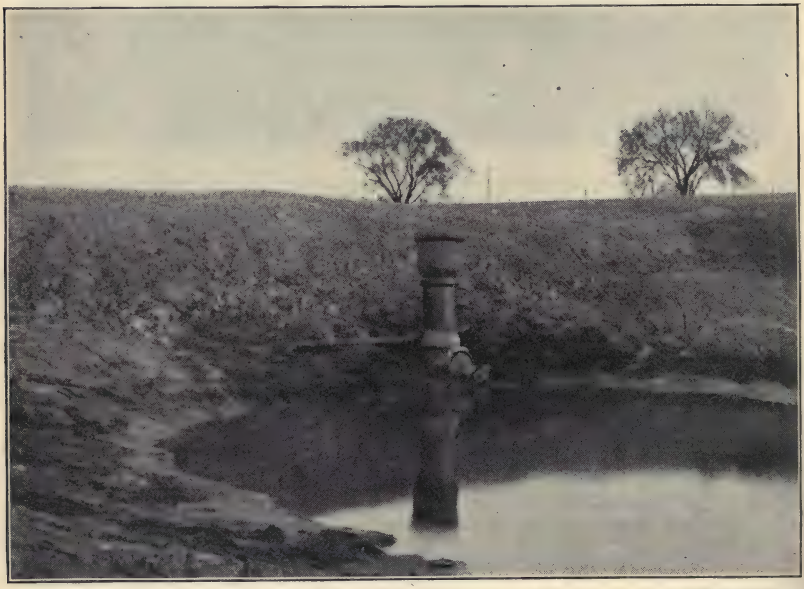

B. P. R. D-3903

FIG. 25.—Vertical inlet pipe newly constructed, showing hopper pipe on top and end of T plugged with vitrified clay stopper cemented in the pipe. Near Marshall, Mo.

In the other type of earth soil-saving dam vitrified sewer pipe is generally used to carry the water through the dam. A cross-sectional view of a dam of this type is shown in figure 24. Water from heavy rain fills the basin above the dam, the silt settles to the bottom of the basin, and the water flows through the vertical inlet pipe and the pipe through the dam into the gully below the dam. When the basin is filled to the top of the inlet pipe another section of pipe may be added and the filling continued. The top of the inlet pipe should be at least 3 feet below the top of the dam, and where conditions permit the top of the dam should be at least 1 foot higher than the firm ground on the sides of the gully after the dam has settled, so that if an unusual rain occurs—a heavier rain than the pipe can handle—the water will flow over the firm ground, not over the top of the dam. The vertical inlet pipe should preferably be set 10 feet or more from the inside toe of the dam, because at that distance it is not likely to become clogged with floating trash that usually accumulates near the dam and there is less danger of eddying water around the inlet pipe causing a break in the dam. Nevertheless the usual practice is to set the inlet pipe close to the dam, because less pipe is required. This practice is no doubt responsible for a great many failures.

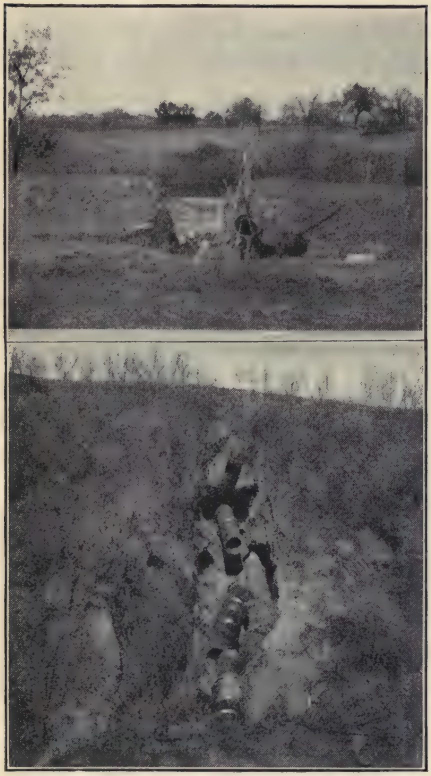
Another precaution against possible clogging of the inlet pipe is to wrap ordinary woven fence wire round four posts set around the pipe so that the bottom of the wire is a little lower than the top of the inlet pipe. This permits the water to pass but keeps out the floating trash. Where it is desired to keep the gully drained above the dam and prevent the formation of a pond, the vertical inlet pipe is joined to the horizontal pipe by a tee connection, and to one end of the tee is connected a drain pipe that extends up the gully.

In many instances farmers desire to make the dam serve the double purpose of filling the gully and furnishing a watering place for stock. In such cases an elbow connection is used in place of the tee, or the end of the tee is plugged with a vitrified clay stopper cemented in the pipe. A foundation of stone or concrete should be provided for the tee or elbow of the inlet pipe to rest upon. The flow of the water into the vertical inlet pipe can be facilitated by placing a hopper pipe on top of the vertical inlet (fig. 25).

The pipe through the dam and the joints of the vertical inlet pipe, with the exception of the top one, should be cemented. Great care should be used in laying the pipe through the dam. A trench with enough fall to prevent water from standing in the pipe should be dug in the bottom of the gully, and holes should be dug under the bell of each pipe so that the barrel rests on firm ground. After the joints are cemented and dried, clay soil should be placed around the pipe and thoroughly tamped. Tamping should be continued over the pipe until it is covered with 2 or 3 feet of soil. Unless the soil forms a close bond with the pipe, seepage of water along the pipe is likely to occur, which often washes a hole through the dam (fig. 26). Seepage along the pipe can be prevented by building a concrete cut-off wall at the middle of the dam as shown in figure 24. If a firm and even foundation for the pipe is not obtained a little unequal settlement due to the weight of the earth above may cause leakage by breaks in the joints of the pipe.

Some sort of protection against erosion should be provided where the water discharges from the outlet pipe into the gully below. More important than preventing erosion of the gully below the dam is the prevention of undermining and eating-back through the dam along the pipe. In figure 24 is shown a channel built of concrete to stop erosion at the outlet of the tile. This channel is usually made 6 to 10 feet long, depending upon the vertical drop of the water. The greater the vertical drop the greater will be the velocity and eroding power of the water. Where it is desired to keep the water out of the gully below the dam the tile can be extended beneath the ground down through the gully to a suitable outlet.

Under "Outlets for Soil-saving Dams" (p. 38) the size of outlet pipe required is thoroughly discussed and in Table 1 are given the sizes of pipe to use for soil-saving dams. Where the pipe used is too small, overtopping and washing out of the dam generally occur.

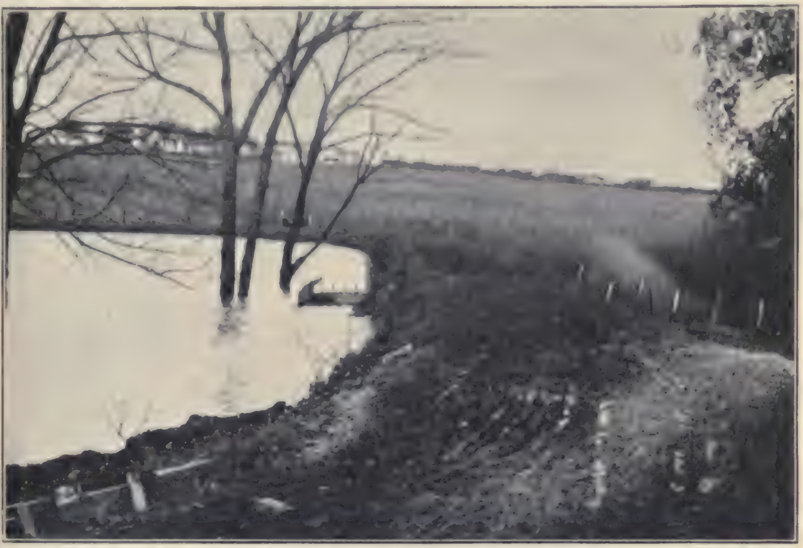


B. P. R. D-3902

FIG. 26.—Results of water seeping along outside pipe through a dam.

After the location for the dam is chosen the foundation should be prepared by clearing away all weeds, growths, and débris and plowing the site to reduce the possibility of seepage along the bottom of the dam. Another precaution against seepage which it is often advisable to observe, especially where the dam is 10 feet or more in height, is to dig a trench the length of the dam 6 to 10 feet wide and 1½ feet deep. The sides of the trench should be made vertical so as to break the seam between the natural ground and the dam, and the bottom of the trench should be plowed. The dam should be built in layers about 1 foot in depth. It is usually built with teams and scrapers, the material being tamped and compacted by the horses' feet and the scrapers. The best results are obtained when the loose earth is sprinkled with water, which facilitates the compacting of the embankment and makes it more impervious. The top of the dam should be not less than 4 feet wide, the side slopes on both faces of the dam not less than 1½ horizontal to 1 vertical. The top of the dam should be not less than 3 feet above the bottom of the spillway or top of the vertical inlet pipe. In figure 24 is shown a section recommended for an earth soil-saving dam.

The best material for building an earth dam consists of 1 part clay to 2 or 3 parts gritty earth. Where water is not available for dampening the material it is best to construct the dam during the rainy season so that the earth in the borrow pit may be kept damp by rains. Material for building dams should preferably be taken from above the dam, 20 to 25 feet above the upstream toe. An allowance of about 10 per cent should be made for the settlement of the material in the earth embankment.

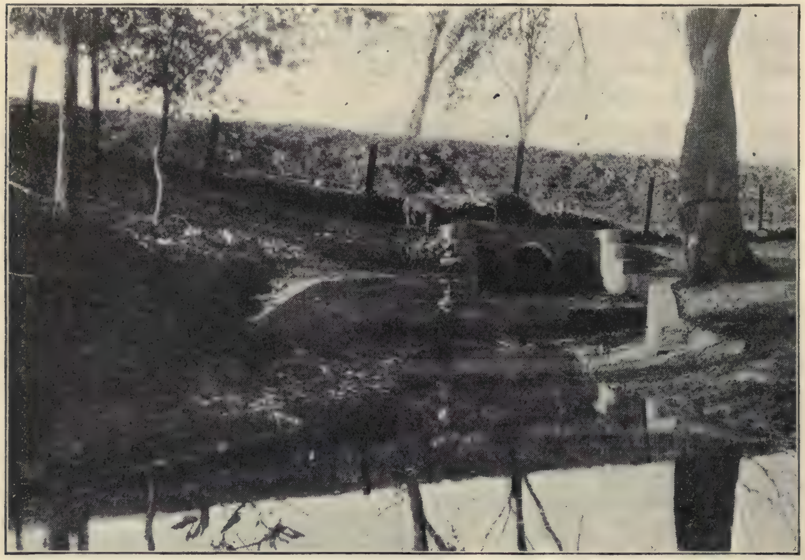


B. P. R. D-3878

FIG. 27.—Earth soil-saving dam with roadway across the top. The vertical inlet is a concrete structure 5 feet wide by 10 feet long with 3 30-inch sewer pipes. The outlet ends of these pipes are shown in figure 28. Near Kansas City, Mo.

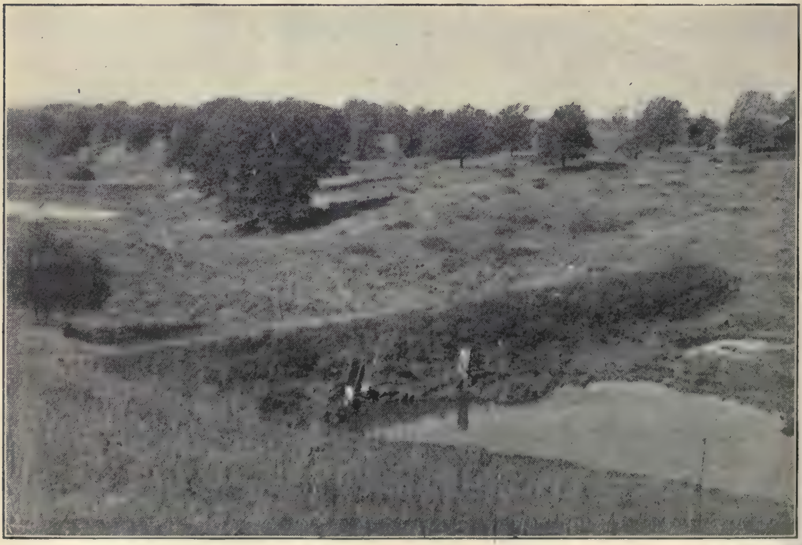
Where the top of the earth dam is used as a roadway it should be at least 8 feet wide. In figure 27 is shown a private road across an earth soil-saving dam. This roadway is 12 feet wide and affords a very convenient means of crossing the wide depression in the field. In figure 28 is shown the outlet end of the same dam.

The popularity of the drop-inlet, earth soil-saving dam is growing rapidly. In Saline County, Mo., several hundred have been built, one farmer having 14 on his farm. In this county they are made in small as well as large gullies and are placed one above another in the same gully so that the fill from one reaches nearly to the outlet of the next dam above (fig. 29).



B. P. R. D-3877

FIG. 28.—Outlet end of dam shown in figure 27. Note the substantial head wall and the concrete floor below to prevent erosion and undermining. Near Kansas City, Mo.



B. P. R. D-3909

FIG. 29.—Two large earth soil-saving dams in one draw where formerly a gully existed. Near Warrensburg, Mo.

DROP-INLET HIGHWAY CULVERTS.

In many sections of the country gullies are a source of much trouble and expense in the construction and maintenance of public highways. Bridges are required to cross them, and where the gullies are growing wider the length of the bridges must constantly be increased. A notable example is a bridge over a gully near Falls City, Nebr. Twenty-five years ago the gully did not touch the road; since then it has crossed the road and continually widened. A trestle 185 feet long crosses the gully, and its length has been repeatedly increased as the abutments for the approach spans have been undermined by the caving in of the sides of the gully from time to time. The drainage area above this bridge is only about 70 acres, the water from which could be readily removed by a moderate-sized culvert. In this case further erosion could be stopped by building a road embankment with combined concrete drop-inlet and culvert as shown in figure 30.

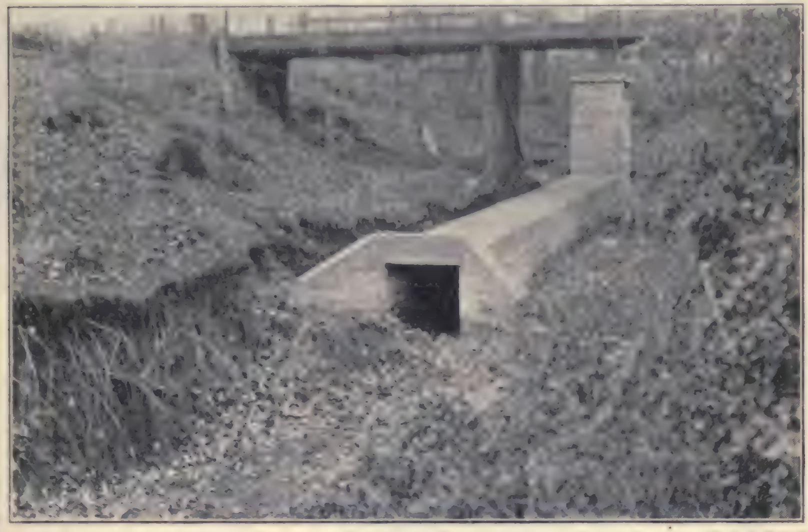

B. P. R. D 3447

FIG. 30.—Highway bridge to be replaced by an earth embankment and a combined culvert and concrete drop inlet. Near Winterset, Iowa.

In figure 31 is shown a close view of a concrete drop-inlet, and in figure 32 is shown its design, which was furnished by E. B. Hiatt, county engineer, Madison County, Iowa. The cover over the drop-inlet prevents animals from falling in. This cover interferes with the flow to some extent. In place of the cover a fence may be built to keep animals out. In figure 33 is shown a fill of soil 8 feet deep above a road embankment in what was formerly a deep gully. The fill extends to the top of the drop inlet. The top of the roadway should be 4 or 5 feet higher than the top of the inlet pipe as a factor of safety against overtopping the embankment after heavy rains.

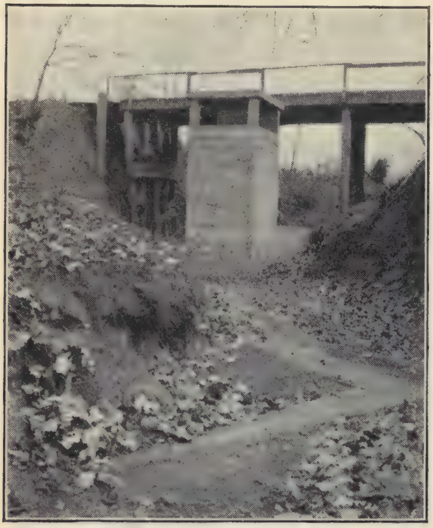


FIG. 31.—Drop inlet and box culvert. Plan shown in figure 32. The old wooden bridge is to be replaced by an earth fill.

Gullies of the waterfall type often eat their way slowly up a watercourse toward a highway. Generally no attempt is made to check the gully until it has reached the road. The usual method then employed to stop the gully from crossing the roadway is to build a concrete structure to prevent further erosion of the gully and the undermining of the roadway and culvert. Figure 2 (p. 5) shows such a structure built at a great expense to the county. At the time the picture was taken the structure was partly undermined. About a year after the work was completed the roadway and structure were washed out. The failure was due to a poor foundation and to the concrete not extending far enough from the culvert. Where such structures are required they should be properly designed and carefully constructed. It is

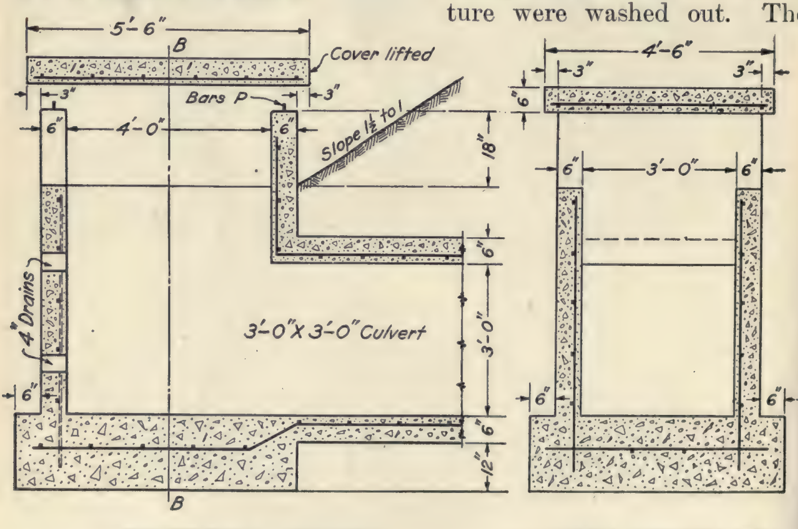


FIG. 32.—Reinforced concrete drop inlet for box culvert[1] shown in figure 31.

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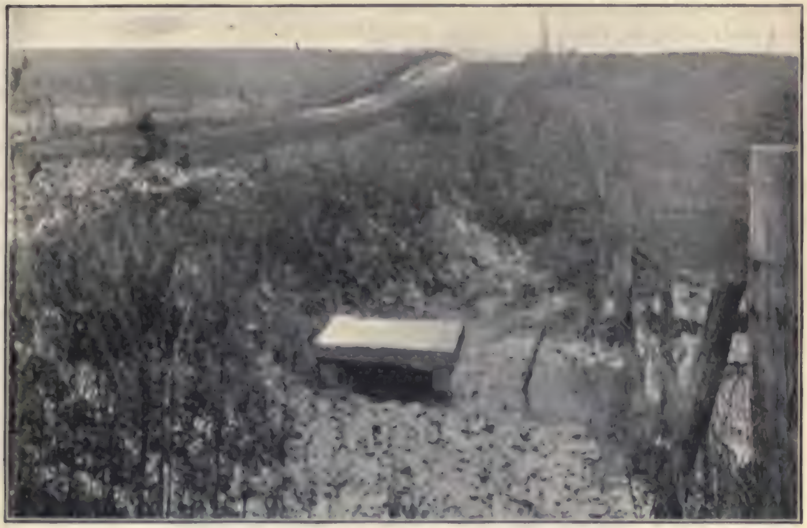
[1] Designed by E. R. Hiatt, county engineer, Winterset, Iowa.

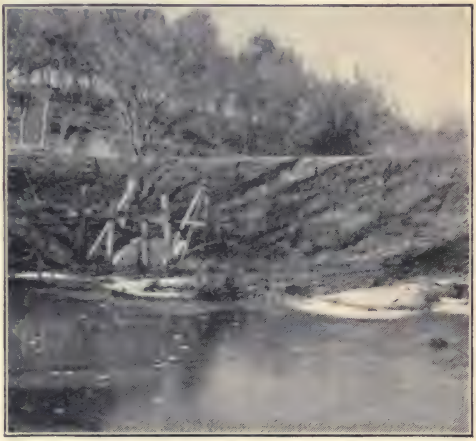
invariably more satisfactory and inexpensive to stop the gully in the farmer's field before it has reached the roadway.

In building a road embankment to cause a fill in the gully above by the use of the drop inlet more care should be taken than in building an ordinary embankment not subject to water pressure from above. The best material should be placed and carefully tamped around the barrel of the culvert and on the upstream side of the embankment. Where it is difficult to make a satisfactory bond between the earth and the concrete culvert, one or two concrete cutoff walls should be built around the barrel of the culvert to prevent seepage along it.



B. P. R. D-4122

Fig. 33.—Fill of soil 8 feet deep, extending to the top of the drop inlet, taken one year after the completion of the work. Near Winterset, Iowa.



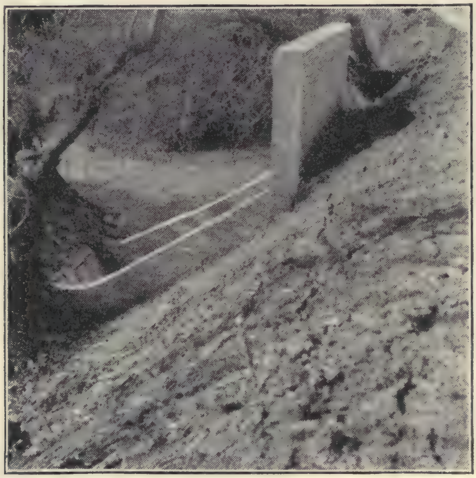
B. P. R. D-3489

Fig. 34.—Road embankment and concrete drop inlet replacing an old bridge that was 60 feet long and 35 feet high. Depth of fill is 12 feet. Near Falls City, Nebr.

A great many of these concrete drop inlets have been built by Mr. Hiatt and by J. F. Relf, county engineer, Richardson County, Nebr. An installation from which excellent results have been obtained is shown in figure 34. In this case a long highway bridge was replaced by an earth embankment and a deep gully was filled to the top of the drop inlet.

The kind of inlet used in Richardson County, Nebr., is shown in figure 35. From the crest of the inlet to the bottom of the culvert the wall is made sloping so as to give the water at entrance a direction of flow conforming more nearly to that of the flow through the culvert than is the case for an inlet with vertical walls. No cover is placed over the inlet, as it is especially designed to facilitate the entrance of the water. This type of inlet is quite commonly added to existing concrete culverts where it is desired to fill a gully above a road embankment.

In the above-named counties many landowners have shown a desire to cooperate by sharing in the expense of building the drop-inlet culverts. In this way many old wooden bridges are being replaced by earth embankments and many gullies are being filled and reclaimed for production.



B. P. R. D-3499

FIG. 35.—Concrete drop inlet with sloping wall from crest to bottom of culvert to facilitate entrance of water. Near Falls City, Nebr.

OUTLETS FOR SOIL-SAVING DAMS.

The chance against failure of a soil-saving dam depends primarily upon the adequacy of the outlet. The outlet may be a spillway that carries the water over or around the end of the dam, a pipe or conduit that carries the water through the dam, or often a combination of the two. The rate at which the water should be carried depends upon the size, shape, and topography of the watershed area, upon the quantity of water that can be stored by the dam, and upon the intensity and amount of heavy rains.

Table 1.—Cross-sectional areas of pipe or conduit for drop-inlet, soil-saving dams for rolling watersheds with length equal to about twice the width.

Drainage area.	With no spillway around or over dam.				With spillway having capacity about half that of pipe in column 2; storage, ½ acre at level of top of inlet pipe.	
	Very little storage above dam.		Storage above dam, surface area, ½ acre at level of top of inlet pipe.			
	4-foot drop.	8-foot drop.	4-foot drop.	8-foot drop.	4-foot drop.	8-foot drop.
Acres.	*Sq. ft.*	*Sq. ft.*	*Sq. ft.*	*Sq. ft.*	*Sq. ft.*	*Sq. ft.*
1	0.4	0.3	0.2	0.1	0.05	0.0
2	.7	.5	.35	.2	.1	.0
4	1.1	.8	.6	.3	.15	.0
6	1.5	1.1	.8	.5	.2	.0
8	1.9	1.4	1.1	.65	.25	.0
10	2.2	1.7	1.3	.8	.30	.0
15	3.0	2.3	2.0	1.2	.4	.1
20	3.8	2.8	2.7	1.7	.5	.2
25	4.5	3.4	3.4	2.2	1.1	.3
30	5.1	3.8	3.9	2.6	1.2	.5
35	5.8	4.3	4.5	3.1	1.5	.7
40	6.3	4.8	5.1	3.5	1.8	1.0
45	6.9	5.2	5.7	4.0	2.2	1.2
50	7.5	5.6	6.3	4.4	2.6	1.5
60	8.6	6.5	7.6	5.4	3.2	2.2
70	9.7	7.3	8.6	6.2	3.7	2.5
80	10.7	8.0	9.6	6.9	4.2	2.9
90	11.7	8.8	10.6	7.7	4.8	3.3
100	12.6	9.5	11.6	8.4	5.3	3.7
125	15.0	11.2	14.1	10.4	6.7	4.8
150	17.2	12.9	16.7	12.4	8.2	6.0
175	19.2	14.4	19.2	14.4	9.6	7.2
200	21.3	16.0	21.3	16.0	10.6	8.0
300	28.8	21.6	28.8	21.6	14.4	10.8
400	35.8	26.8	35.8	26.8	17.9	13.4
500	42.3	31.7	42.3	31.7	21.1	15.8
600	48.5	36.4	48.5	36.4	24.2	18.2
700	54.4	40.8	54.4	40.8	27.2	20.4
800	60.2	45.2	60.2	45.0	30.1	22.5
900	65.7	49.3	65.7	49.2	32.8	24.6
1,000	71.1	53.3	71.1	53.3	35.6	26.6

For very hilly watersheds increase above cross-sectional areas 25 per cent.
For square or fan-shaped watersheds increase above cross-sectional areas 15 per cent.
For sizes of pipes corresponding to the above cross-sectional areas see Table 2.

Table 2.—Cross-sectional areas of pipes of standard diameters for use in selecting sizes corresponding to areas in Table 1.

Diameter of pipe.	Cross-sectional area of pipe.	Diameter of pipe.	Cross-sectional area of pipe.
Inches.	*Sq. ft.*	*Inches.*	*Sq. ft.*
6	0.20	27	3.98
8	.35	30	4.91
10	.55	33	5.94
12	.79	36	7.07
15	1.23	39	8.30
18	1.77	42	9.62
21	2.41	45	11.04
24	3.14	48	12.57

In concrete or masonry structures provision should be made for the water to flow over the entire length of the dam in case of unusually heavy rains. The sides of the dams should be extended as high as the banks of the gully or as high as the highest water expected in the gully.

In the case of earth soil-saving dams a spillway should always be provided around one or both ends of the dam, where possible, by building the top of the dam higher than the natural firm ground on either side of the gully. The greater this height the greater will be the factor of safety against the dam being overtopped and washed out. Spillways built of hard material over the tops of earth dams are not recommended, because of the difficulty of maintaining them and the danger of undermining at their lower end.

It is important that the pipe through a drop-inlet soil-saving dam be made large enough to provide for the removal of heavy rainfalls rapidly enough to prevent overtopping. In Table 1 are given the sizes of pipe or conduit adapted to specified conditions. This table is based upon observations of soil-saving dams that are giving satisfactory service and upon areas drained by culverts through highway and railroad embankments. In column 2 are given the cross-sectional areas of a pipe or conduit required for a soil-saving dam where no spillway is provided for the water to flow over or around the dam, where the storage above the dam is very small, as in a narrow valley with a steep slope, where the drop from the top of the inlet pipe to the center of the outlet end of the pipe through the dam is 4 feet, and where the watershed above the dam is rolling and about twice as long as wide.

In column 4 are given the cross-sectional areas required where the conditions are the same as for column 2 except that considerable water is stored above the dam, which has the effect of reducing considerably the size of pipe required for small watersheds, but very little for watersheds 100 acres or more in extent. The surface area of the water stored is assumed to be one-half acre. The area of conduit required can be increased or decreased according as the surface area of the water stored is less or greater than one-half acre.

In column 6 are given areas required where the conditions are the same as for column 4 except that provision is made to carry water over a spillway around the dam with a capacity equal to one-half of the capacity of pipes or conduit with areas as given in column 2. With a depth of about 1½ feet of water in the spillway, to remove through it the same amount of water as will be passed by a drop inlet with 4 feet drop, the cross-sectional area of the spillway should be from four to eight times that of the drop inlet, depending upon the distance the water would have to flow to go around the end of the dam and back into the gully below; the greater this distance the less will be the flow of the water. The spillway capacity can be increased as desired by increasing the height of the dam.

Suppose it is desired to know the size of a pipe or conduit required for a rolling watershed of 25 acres with length equal to about twice the width, where the surface area of the water stored above the dam would be about one-half acre, where no provision would be made for a spillway round or over the dam, and where the vertical drop from the top of the inlet to the outlet end of the pipe would be 8 feet. In the first column in Table 1, under "Drainage area in acres," find 25, then follow the line across the page to the right to the fifth column, which falls under three heads at the top of the table. First, no spillway round or over dam; second, storage above dam, surface area one-half acre at level of top of inlet pipe; third, 8 feet drop. The number in the fifth column is 2.2, which means that the pipe through the dam should have an area of 2.2 square feet. In Table 2 it is found that an 18-inch pipe has a cross-sectional area of 1.77 square feet and a 21-inch pipe 2.41 square feet. A 21-inch pipe should be chosen, since no smaller standard-sized pipe is made which has the required area.

Where several drop-inlet, soil-saving dams are built in a gully, the outlet pipe for the upper dam should be chosen as explained above. The size of the outlet pipe for the next dam below will depend upon several governing conditions: (1) If the storage above the upper dam and the additional watershed area drained by the gully between the dams are negligible, the outlet pipe for the lower dam should be of the same size as for the upper dam; (2) if the storage above the upper dam is negligible and there is a large additional watershed area between the dams, then the size of the outlet pipe should be chosen from Table 1 for the total watershed area above the lower dam; (3) if there is considerable storage above the upper dam and a negligible watershed area between the dams, the pipe for the lower dam might be smaller than for the upper dam, yet on account of the difficulty of ascertaining just how much smaller the pipe could be, a safer practice would be to use the same size of pipe for both dams; (4) if there is considerable storage above the upper dam and a large watershed area between the dams, the outlet pipe should be chosen from Table 1 for a watershed equal to the sum of the watershed area between dams and a certain part of the watershed area above the upper dam, depending upon the reduction in flow effected by the upper dam storage. It is impossible to say just what part of the upper watershed should be included, since hardly any two cases would be similar, but this information can be obtained from an engineer after an examination of the watersheds and the dam sites.

The waterway through the dam may be a pipe or a concrete box. Standard vitrified clay sewer pipe can be obtained up to 36 inches and concrete pipe up to 48 inches in diameter. Where a cross section greater than that of a 36 or 48 inch pipe is required a concrete conduit of the required cross-sectional area can be built.

Where the outlet pipe is extended down the gully as an underdrain, a very good practice since it prevents erosion at the outlet and in the gulley below, a somewhat larger tile would be required than that indicated in Table 1, the size of which should be determined by an experienced engineer.

HOW TO RECLAIM A GULLY WITH SOIL-SAVING DAMS.

Before beginning work a plan should be decided upon for the reclamation of the entire gully. Too often a small section of a gully is reclaimed in a way which will not fit into any later scheme for the reclamation of the whole gully. Attention should first be directed to the upper end, where head erosion is going on. This should be stopped by building an overfall of brush and straw, as has been described, by constructing a flume for conducting the water into the gully without erosion or by the diversion of the water from the head of the gully.

Next, plans should be made for filling the gully. If the gully decreases gradually in depth toward the lower end and terminates in a wide, shallow depression, a number of low, temporary dams can be used. If the gully terminates in the side of a deep drainage channel, however, the lower end can not be filled by a low dam, and a high one must be built where the gully enters the channel. Although the higher the dams the fewer that will be required to fill a gully, yet unless conditions make it necessary to use high dams low ones should be used, since the cost will be less, and low dams are much less subject to failure.

Often the erosion of soil from the watershed is very slight, and a number of years would be required to fill the gully. This is especially the case where the watershed is in pasture, meadow, or timber. In such cases a series of dams of the overflow type should be built, so that some silt will be caught above each one, or a dam may first be built at the lower end of the gully and other dams later built in succession above after the gully is partly filled in. The side slopes of the gully should be plowed in, so that farming operations can be conducted in and across the gully.

Some gullies occur in the natural drainage channels of fields and have large drainage areas, while others occur on the slope of a hillside with very small drainage areas which are not well defined. Gullies of the latter type may be entirely filled and then prevented from washing out by proper cultural methods or by terracing. Gullies with large, well-defined drainage areas can not be entirely filled, since it is necessary that a waterway be left large enough to carry the water from the watershed. A very common mistake is so to reduce the size of the waterway by filling in the gully that the drainage water overflows the banks of the gully; this often proves disastrous to reclamation works. The size of the waterway that should be left can be judged from the high-water flow in the gully due to the heaviest rains that have occurred in the past.

SPACING DAMS IN A GULLY.

In reclaiming the whole length of a gully a series of dams is built along its length, the distance between the dams depending upon their height and the slope of the gully. The less the slope of the gully or the greater the height of the dam the greater may be the distance between the dams. Usually the dams should be so spaced that the fill that accumulates to the top of one dam extends to the foot of the next dam above. A dam will cause a fill that is higher at some distance above than at its foot. The fall of the surface of the fill in the gully will not much exceed 6 inches in 100 feet, and in computing the distance between dams so that the fill will extend from the top of one dam to the foot of the next this rate of fall has been assumed and values for Table 3 were computed accordingly. The table gives the distances between dams in a gully for dams ranging from 2 to 10 feet in height and for gullies with falls ranging from 2 to 20 feet in 100 feet.

Table 3.—Distances between dams in gullies for dams of various heights and gullies of various bottom slopes.

Height of dam.	Bottom slope of gully.				
	2 feet in 100 feet.	5 feet in 100 feet.	10 feet in 100 feet.	15 feet in 100 feet.	20 feet in 100 feet.
	Distances between dams.				
Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
2	133	44	21	14	10
3	200	67	32	21	15
4	267	89	42	28	20
5	333	111	53	34	26
6	400	133	63	41	31
7	467	156	74	48	36
8	533	178	84	55	41
9	600	200	95	62	46
10	667	222	105	69	51

Sometimes there are contracted sections in gullies that are naturally suitable for the location of dams. Under such circumstances it may be desirable to disregard the spacing as given in the table and build the dams high enough to conform to the spacing naturally suggested. With the actual distances between the dams determined, the required heights can be taken from the table.

As a general rule it is cheaper and more satisfactory to reclaim gullies with low rather than with high dams. A low dam costs considerably less and requires less care and attention than a high dam.

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FARMERS' BULLETIN · 1235
UNITED STATES DEPARTMENT OF AGRICULTURE

GAME LAWS
for 1921

A Summary of the Provisions of Federal, State, and Provincial Statutes

THE objects of this bulletin, containing the twenty-second annual summary of Federal and other game laws and regulations, are to present the provisions of game legislation in convenient form for sportsmen and others and to show its general condition and trend from year to year.

Provisions relating to methods of capture, game refuges, enforcement of laws, disposition of fees and fines, and matters of minor importance are omitted. These may be found by reference to the laws themselves, pamphlet editions of which are obtainable in most of the States from proper officials.

Provisions relating to seasons, licenses, limits, possession, sale, and export, and a few miscellaneous matters are presented, under State and other governments, alphabetically arranged, thereby furnishing the reader a brief and convenient synopsis of the laws.

Contribution from the Bureau of Biological Survey
E. W. NELSON, Chief
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GAME LAWS FOR 1921.

A SUMMARY OF FEDERAL, STATE, AND PROVINCIAL STATUTES.

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REVIEW OF LEGISLATION OF 1921.

Regular legislative sessions were held in 1921 in all States, except Maryland, Virginia, Kentucky, Alabama, Mississippi, and Louisiana, and of the 42 States holding sessions all but 5—Iowa, Oklahoma, Texas, Arizona, and Utah—made changes in their game laws.[1] More or less complete revisions of the game laws were made by Idaho, Kansas, Montana, Nebraska, Oregon, Washington, West Virginia, and Wyoming.

MIGRATORY BIRDS.

During the year the migratory-bird treaty-act regulations with respect to bag limits were amended by providing that the daily bag limit of any person "shall include all birds taken by any other person who for hire accompanies or assists him in taking migratory birds." This puts an end to the abuse of privileges under the regulations regarding the prescribed daily bag limits by persons who claim that birds were killed by guides accompanying them. The Federal waterfowl season for California was fixed from October

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[1] The legislature of Georgia did not convene until late in June, and at the time of going to press no information was available concerning action taken on game matters.

1 to January 15, replacing the old season of October 16 to January 31, the season now being the same under both Federal and State laws. Regulation 9 governing the issuance of Federal scientific permits was amended to permit the issuance of limited and special permits.

State legislation harmonized Federal and State laws on waterfowl and shorebirds in Kansas and Oregon, and on waterfowl in Pennsylvania and Rhode Island; Washington prescribed a State-wide open season on all migratory game birds from October 1 to January 15, thus deviating from the Federal regulations, which supersede the State law, east of the Cascade Mountains, where it will now be possible to hunt migratory game birds only from October 1 to December 31, without violating either Federal or State law; in Idaho the open season on migratory game birds has been shortened under State law two weeks by opening October 1 instead of September 16 and extending to December 31.

Idaho, Kansas, Montana, Nebraska, Oregon, and Washington enacted legislation similar to the Federal regulation prohibiting hunting from airplanes. Colorado reduced the bag limit on ducks from 20 to 15 a day, while Kansas increased the limit from 20 to 25. In New Jersey reedbirds were protected at all times by being placed in the nongame-bird class; thus the provisions of the order of the Secretary of Agriculture (see page 73) permitting the killing of these birds from September 1 to October 30, for the protection of rice crops in the South, is unavailing in the State. The open season for woodcock was shortened 25 days in Michigan, two weeks in New York, and one month in Vermont. Doves were protected until 1924 in Colorado; and in Kansas an open season on them was provided from September 1 to October 15.

UPLAND GAME BIRDS.

In Michigan the season for ruffed grouse was shortened 25 days and made uniform throughout the State; in Vermont, after having been protected by a two-year close season, ruffed grouse may now be hunted during the month of October; Maine for the first time prescribed a season limit on ruffed grouse, which was fixed at 25. Colorado protected sage hens until 1924, and reduced from 15 to 10 the number of prairie chickens and grouse allowed in possession at one time. Kansas prescribed an open season from September 20 to September 30 for prairie chickens—ending the close season in existence since 1912—and limited the bag to 5 a day. Prairie chickens and sharp-tailed grouse, protected by a close season in Minnesota since 1918, may now be hunted in that State from September 16 to October 1 in alternate years, beginning in 1921. Prairie chickens, sage hens, and grouse are now protected by continuous close season in Montana, except in Flathead, Lincoln, Missoula, and Sanders

Counties, where they may be hunted during the first fifteen days in October. Oregon shortened the open season two weeks on grouse, Chinese pheasants, and bob-white quail west of the Cascade Mountains. Pennsylvania limited the season on upland game to one month by opening November 1 instead of October 20. Quail have been given protection by a continuous close season in New Hampshire, and in Kansas by a close season during odd years, the open season during even years being from December 1 to December 10.

BIG GAME.

In general, seasons on big game were shortened and hunting further restricted. Buck laws were enacted in Michigan, Montana, Nevada, North Dakota, South Dakota, Vermont, and in Washington east of the Cascades. Maine protected spike bucks and prescribed that one of the two deer allowed in the eight northern counties—Aroostook, Franklin, Hancock, Oxford, Penobscot, Piscataquis, Somerset, and Washington—must be an antlered buck, and provided that in Hancock and Washington Counties only residents may hunt deer during the last two weeks of the open season. West Virginia continued protection on does and fawns indefinitely, prohibited the killing of bucks for a period of two years, and required that thereafter hunters report the killing of buck deer to the commission. Deer seasons were shortened in Idaho, Minnesota, Missouri, Montana, and New Hampshire.

Bull moose were protected for five years in Maine; and the season on them in Minnesota shortened ten days. Wyoming provided that the commission may sell not to exceed 100 permits for killing bull moose and 100 permits for killing buck antelope from September 15 to October 31 in such sections as they may designate, on the payment of fees for moose of $100 and $50 by nonresidents and residents, respectively, and for antelope $50 and $25, respectively.

In Idaho the open season on elk was reduced in four counties from three months to two weeks; in Montana the territory in which elk hunting is permitted was further restricted and the open season reduced by about six weeks; the law under which a special $25 license was issued, authorizing the killing of two additional elk in Park and Gallatin Counties, Montana, was repealed. Wyoming shifted the elk season to open two weeks earlier.

Washington closed the season on mountain goats west of the Cascades, thus protecting them throughout the State; while Wyoming slightly lengthened the season on male mountain sheep and prescribed September 15 to November 5 as the open season, instead of the month beginning October 15, and prohibited the killing of sheep except those having horns with not less than one-half curl.

Michigan created a fund by authorizing the setting aside of part of the deer-hunting license fees for the hiring of trappers and hunters to destroy predatory animals; and Montana authorized the commission to make appropriation from the funds at its disposal for the eradication of predatory animals that destroy game.

GAME REFUGES.

The establishment of new refuges was limited to the Pike's Peak, Spanish Peaks, Denver, and a special antelope preserve in Colorado; a game preserve and game farm bordering Albert Lea and Fountain Lakes, in Freeborn County, Minnesota; the Blackleaf Game and Bird Reserve in Teton County, and the Beaverhead Fish and Game Preserve in the Beaverhead National Forest, Montana; and the Campbell County State Game Refuge in Wyoming, the last named having been established by order of the State commission. The powers of the commissions of New Jersey, Ohio, and West Virginia relating to the creation of game refuges and preserves on private holdings were greatly enlarged, and the commission of West Virginia was authorized to investigate sites for refuge and park purposes and to make special reports thereon to the governor. Kansas enacted legislation authorizing the establishment of game refuges on private lands; and Washington authorized the county game commissioners to set aside such areas in national forests as the Chief Forester of the United States shall consent in writing to be set aside as game preserves. In Wyoming the commission enlarged or modified the boundaries of the following existing game preserves: Big Horn, Careyhurst, Carter Mountain, Hoodoo, Popo Agie, Shoshone, and Splitrock. Refuges, preserves, and shooting grounds in New Mexico for the express purpose of providing safe sanctuaries in which game may breed and replenish adjacent hunting ranges have been authorized by broad powers conferred upon the new commission, the idea being to establish small rather than large refuges and to make unnecessary the closing of large areas to hunting. In order to encourage the establishment of refuges for wild fowl, Minnesota repealed the provision that no refuge may be created on less than 640 acres of contiguous lands.

LICENSES.

The mounting cost of game-warden service undoubtedly is responsible for the enactment of legislation increasing hunting-license fees in no less than ten States. Big-game hunting-license fees were increased in Colorado. The fees for resident small-game licenses in Colorado and for residents on all game in Massachusetts and New Jersey were increased, effective January 1, 1922; resident hunting-license fees for all game were also increased in Michigan, Minnesota, Montana, Oregon, Vermont, Washington, and Wyoming. The fee for nonresident deer licenses in Michigan was increased from $25 to $50; in Kansas the provision granting free licenses to honorably discharged soldiers and sailors of the United States was repealed; and persons hunting, fishing, or taking frogs in West Virginia are now required to take out a $1 combination license. Aliens are prohibited from hunting in Kansas and New Mexico, and in South Dakota are required to secure nonresident licenses.

ADMINISTRATION AND WARDEN SERVICE.

More than ordinary interest was manifested in maintaining efficient departments for the enforcement of State laws protecting wild life, with a marked tendency toward nonpartisan, nonsalaried commissions. In California, sportsmen and conservationists, after a prolonged fight, succeeded in having defeated efforts to abolish the State fish and game commission and to give the Department of Agriculture jurisdiction over the administration of the fish and game laws; and also efforts to abolish the game-protection fund and place all revenues from fines, penalties, hunting and fishing licenses, and other sources in the general fund. In New York, noted as having the largest, best equipped, and most efficient warden service of any State, strenuous efforts to abolish the warden service and place the administration of the fish and game laws in the hands of the mounted police were defeated by the activity of sportsmen and conservationists; the number of inspectors was decreased, however, from 12 to not more than 10 and the number of protectors was reduced from 131 to not more than 90; but two additional troops of 58 men each were added to the State police force, on which the powers and duties of game wardens were conferred. The life of the commission in Arkansas was seriously threatened, and it was only after strenuous efforts that appropriations to enable its work to be carried on were secured by sportsmen and conservationists, who, being placed on the defensive, made no progress toward regaining ground lost two years ago when the State wardens were deprived of their police power and the number of wardens was reduced. New Mexico and West Virginia authorized the appointment of nonsalaried commissions of three members each for terms of six and three years, respectively, after the expiration of original appointments—replacing the offices of State game wardens—and authorized the appointment of wardens to administer the laws under the direction of the commission. In Michigan a conservation commission of seven nonsalaried members replaces the public domain commission, formerly having charge of the administration of laws relating to protection of fish, game, and forests, and in addition takes jurisdiction in all matters formerly under the State board of fish commissioners, the Geological Survey, and the Michigan State Park Commission. Fish and game commissions were reorganized in Connecticut, Montana, and Oregon, and also in

Wyoming, where the jurisdiction was extended to include fish. Washington abolished the office of State fish commissioner and State game warden and created a Department of Fisheries and Game under a single director, with the administration of the fish and game laws under the direct supervision of a supervisor of game and game fish.

The legislative year contains also its negative results and disappointments. Nevada abolished the office of State Fish and Game Warden, in existence since 1917, and charged the county commissioners with the enforcement of the game laws, giving them power to open a one-month season for deer and antelope between September 15 and December 15; if the commissioners do not act, however, the season for deer and antelope will remain from October 14 to November 12, and the hunter will have the privilege of taking one deer with horns. Failure met renewed efforts to create fish and game departments in Florida and North Carolina and to give added and much needed protection to wild life in those States.

Considerable progress was made toward making fish and game laws more elastic and pliable by authorizing State commissions or wardens to close seasons in Idaho, Michigan, Montana, New Mexico, Oregon, and Wyoming, when necessary to give additional protection in localities where any species of fish or game is threatened with depletion or extinction. In West Virginia the commission was authorized to change the dates of the open season on quail in any county, but must limit the hunting period to not to exceed 30 days. In New Mexico the newly created commission was authorized to close seasons during periods of extreme drought as an aid to preventing forest fires. The Governor of Massachusetts has authority to suspend during a period of drought the open season on squirrels, pheasants, partridge, quail, and woodcock, and now may extend the prescribed open seasons for a period equal to the time covered by such suspension, but the season for woodcock may not be lengthened beyond the dates fixed by Federal regulations.

Six extra deputy wardens with police powers throughout the State were authorized in Kansas and six additional wardens also were authorized in New Jersey. In West Virginia, where the State game warden formerly was limited to the appointment of two salaried deputies, the commission was authorized to appoint necessary game protectors with jurisdiction throughout the State and to fix their salaries. The salaries of State commissioners and State wardens were increased in Michigan, Montana, New Mexico, Ohio, West Virginia, and Wyoming, as were the salaries of deputies in Montana, New Hampshire, Vermont, and Wyoming. The merit system has been inaugurated in Montana, where the wardens now are rated according to efficiency, those rated in the first grade for a full year to receive increased salary at the rate of $120 per annum and a like sum for each year thereafter in which they shall so qualify until the maximum compensation reaches $1,800; while those in the second grade for a full year will receive increased salary at the rate of $60 per annum and a like sum for each year thereafter in which they shall so qualify until they receive a maximum of $1,650.

MISCELLANEOUS.

In Pennsylvania authority was granted the commission to revoke the license of, or deny the right to secure a license for a period of one to five years by, any person violating the game laws, destroying notices posted under the direction of the commission, destroying personal property or crops on land while hunting, carelessly injuring with firearms human beings or live stock, or causing forest fires; and the commissions of New Mexico and West Virginia were authorized to revoke the license of any person violating the game laws or to deny him the right to secure a license. The Legislature of New Jersey gave recorders jurisdiction to try violations of the game laws and conferred on justices of the peace, district courts, and police magistrates the additional authority to try without a jury violators of the game laws.

A license tag must now be displayed on the outer garment between the shoulders of hunters in Pennsylvania, and when such a tag is so displayed but the hunter is unable to exhibit his license in the field he may deposit $20 with the game protector, and upon satisfactory explanation under oath to the game commission within 15 days thereafter it may be refunded by the commission. A coat and hat of dark blue or black material must now be worn by deer hunters while in the field in North Dakota.

Reports as to the kill of deer or wild turkeys in West Virginia now must be furnished the commission, and in Wyoming similar reports must be furnished the commission showing whether any game animals have been killed; and if so, the number, sex, and kind, together with the name of the guide, if any, present when the killing took place.

SUMMARY OF LAWS RELATING TO SEASONS, LICENSES, LIMITS, SALE, AND EXPORT.

The dates of open seasons for migratory game birds shown under the various States and Provinces are the times when these birds may be hunted without violating either State laws or Federal regulations.[2]

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[2] The full text of the migratory-bird treaty, act, and regulations will be found on pages 61–72.

Federal regulations prohibit shooting from sunset to half an hour before sunrise, and prohibit the killing at any time of the following birds:

Band-tailed pigeon; little brown, sand-hill, and whooping cranes; wood duck, eider duck, swans; curlews, willet, upland plover, and all shorebirds (except the black-bellied and golden plovers, Wilson snipe or jacksnipe, woodcock, and the greater and lesser yellowlegs); cuckoos; flickers and other woodpeckers; nighthawks or bull-bats and whip-poor-wills; swifts; hummingbirds; flycatchers; bobolinks,[3] meadowlarks, and orioles; grosbeaks; tanagers; martins and other swallows; waxwings; shrikes; vireos; warblers; pipits; catbirds and brown thrashers; wrens; brown creepers; nuthatches; chickadees and titmice; kinglets and gnatcatchers; robins and other thrushes; and all other perching birds which feed entirely or chiefly on insects; and also auks, auklets, bitterns, fulmars, gannets, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, and terns.

In some States certain days of the week constitute close seasons throughout the time in which killing is permitted. Hunting on Sunday is prohibited in all States and Provinces east of the one hundred and fifth meridian except Illinois, Louisiana, Michigan, Texas, Wisconsin, and Quebec. Mondays constitute a close season for waterfowl locally in Maryland and North Carolina; and certain other week days for waterfowl in several favorite ducking grounds in Maryland, Virginia, and North Carolina. Hunting is prohibited on election day in Maryland in Allegany, Baltimore, Cecil, Charles, Frederick, and Harford Counties; and when snow is on the ground in New Jersey, Delaware, Virginia, and Maryland.

The county laws of North Carolina are too numerous to be incorporated in the following summary, which otherwise may be regarded as a practically complete résumé of the regulations now in force.

The migratory-bird treaty-act regulations permit the possession of migratory game birds during the open season and the first 10 days following the close of the season. This provision has been considered in connection with State laws, and when migratory game birds may be legally possessed under Federal regulations and State laws during any part of the close season, it has been stated under the heading "Bag limits and possession." Possession of nonmigratory game during the close season is generally prohibited by State laws, but when an extension of a few days or a special season is provided for either possession or sale attention is called thereto.

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[3] See order of the Secretary permitting bobolinks, or reedbirds, to be killed in a few States for the protection of rice crops in the South, p. 73.

Under the Federal migratory-bird treaty act the sale of all migratory game birds is prohibited throughout the United States (except birds taken for scientific or propagating purposes, and waterfowl raised on farms or preserves, under proper permit from the Secretary of Agriculture—see regulations 8 and 9, pages 70–72).

In stating the open seasons[4] the plan of the New York law, to include the *first and last days thereof*, has been followed. The difficulty of securing absolute accuracy in a statement of the seasons is very great, but the following summaries have been submitted to the proper State or Provincial game commissioners for approval, and are believed to be free from material errors. Species (including migratory game and nongame birds protected throughout each year by Federal regulation) on which the season is closed for a term of years or an indefinite period are grouped under the term "No open season." Provisions of State laws prohibiting hunting at night, between sunset and sunrise, or during certain hours, are not included.

Persons are advised to secure from the State game commissioners[5] the full text of game laws in States where hunting is contemplated.

State Laws.

ALABAMA.

Open seasons:[6]	*Dates inclusive.*
Deer (male)	Nov. 1–Jan. 1.
Squirrel (black, gray, fox)	Sept. 15–Feb. 1.[7]
Bear, quail (partridge)	Nov. 1–Mar. 1.
Ruffed grouse (pheasant), introduced pheasant, or other introduced game bird	Nov. 15–Dec. 15.
Wild turkey gobbler	Dec. 1–Apr. 1.
Turtle dove	Oct. 16–Jan. 31.
Duck, goose, brant, black-bellied and golden plovers, Wilson snipe, yellowlegs, coot (mudhen), gallinule	Nov. 1–Jan. 31.
Woodcock	Nov. 1–Dec. 31.
Rail, other than coot and gallinule	Sept. 1–Nov. 30.

No open season: Does, elk (1925); hen turkeys, swans, wood duck, bitterns, sandhill and whooping cranes, grebes, gulls, herons, loons, shearwaters, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting licenses: Nonresident or alien, $15. Resident: State, $3; county, $1. Trapping (bears and other fur-bearing animals), $10. Issued by probate judges. Landlords, tenants, and members of families may hunt or trap on own land during open season without license. Written permission required for hunting or trapping on land of another.

Bag limits and possession: One deer, 10 squirrels, 2 turkey gobblers, 25 of each other kind of upland game bird a day; 25 ducks, 8 geese, 8 brant, 15 in all of plovers and yellowlegs, 25 Wilson snipe, 6 woodcock, 25 sora, and 25 in all of other rails, coots, and gallinules, 25 doves a day. Possession of migratory birds permitted during first 10 days of close season; other game during first 5 days thereof.

Sale: Sale of all protected game prohibited.

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[4] For open seasons on fur-bearing animals, 1921, see Farmers' Bulletin 1238.

[5] See p. 80. A full list of names and addresses of officials and organizations concerned with the protection of birds and game will be found in Dept. Circ. —, U. S. Dept. Agr., 1921.

[6] *Alabama:* Hunting prohibited on all State lands.

[7] Squirrels may be killed at any time on own premises when destroying property.

Export: Export of all protected game prohibited, except that a nonresident licensee may take with him, openly, game he has lawfully killed, but not more than 2 days' limit of migratory birds may be exported in any one calendar week.

Commissioner of conservation may issue a $1 permit to any person to capture or transport not more than 10 pairs of any one species of game bird for scientific or propagating purposes.

ALASKA.

Open seasons:[8]	*Dates inclusive.*
Bull moose, caribou, sheep (rams only south of Arctic Circle) (see exception)	Aug. 20–Dec. 31.
Exception: Caribou on Kenai Peninsula; sheep, Kenai Peninsula, east of longitude 150°, March 1, 1923.	
Deer with horns 3 inches long (southeastern Alaska) (see exception)	Sept. 1–Nov. 15.
Exception: Deer on Duke, Gravina, Kodiak, Long, Kruzof, San Juan, Suemez, Zarembo, Hawkins, Hinchinbrook, and Montague Islands, 1923.	
Mountain goat, east of Cook Inlet and Susitna River (except Kenai Peninsula east of longitude 150°, March 1, 1923) and in Southeastern Alaska east of longitude 141°	Aug. 20–Oct. 31.
Brown bear (north of latitude 62°, unprotected)	Oct. 1–July 1.
Grouse, ptarmigan	Sept. 1–Mar. 1.
Duck, goose, brant, Wilson snipe, black-bellied and golden plovers, yellowlegs, coot, gallinule	Sept. 1–Dec. 15.

No open season: Females and young of deer and mountain sheep, mountain goat kids, and fawns of caribou, south of Arctic Circle; swans, wood duck, eider ducks, auklets, little brown crane, fulmars, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, terns, and all shorebirds (except Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting licenses: Nonresident, $50; nonresident alien, $100. Guide, first-class, $25 (American citizen); second class, $7.50 (native of Alaska—fee fixed by governor).

Shipping licenses: Resident, $40 (export of heads or trophies); $10 (single trophy of caribou or sheep); $5 (single trophy of deer, goat, or brown bear). Special license for shipping one moose killed south of latitude 62°, $150.

(Not more than one general ($40) license and two special ($150) moose licenses issued to one person in one year. Each shipper must file with the customs office at port of shipment an affidavit that he has not violated the game law; that the trophy to be shipped has not been bought or purchased, has not been sold, and is not shipped for purpose of sale; that he is the owner of the trophy, and, in case of moose, whether the animal from which it was taken was killed north or south of latitude 62°.)

Bag limits and possession: Three deer, 2 moose, 3 caribou, 3 sheep, 3 goats, and 3 brown bears a season; 25 grouse or ptarmigan, 25 ducks, 8 geese, 8 brant a day, 25 in all in possession; 15 in all of plovers and yellowlegs, 25 Wilson snipe, 25 shorebirds in possession; 25 in all of coots and gallinules a day. Possession of migratory birds permitted during first 10 days of close season.

Sale: *Prohibited:* Heads, hides, and skins of all protected game; deer meat or serving same in boarding house, café, etc., in southeastern Alaska east of longitude 141°; moose, caribou, sheep, and goats or serving the meat of such animals in any boarding house, café, cannery, eating house, hotel, mess house, or restaurant south of Chugatch or Coast Range Mountains, including Alaska Peninsula, Kenai Peninsula, and east to longitude 141°, and no carcasses or parts thereof of said animals shall be accepted for shipment from Kenai or Alaska Peninsula to other points in Alaska unless accompanied by affidavit of owner that they were not purchased and are not intended for sale. Serving deer or caribou meat on vessels in waters of South Coast of Alaska between Unimak Pass and Dixon Inlet also prohibited. Sale of migratory birds prohibited.

Permitted: Carcasses of all game (except migratory birds, and deer, moose, caribou, and sheep as above stated) may be sold during the open season and 15 days thereafter.

Export: Export prohibited of deer, moose, caribou, sheep, goat, bear, or hides of these animals; wild birds, except eagles, or any parts thereof: *Provided,* Specimens may be exported under restrictions imposed by the Secretary of Agriculture, and trophies of big game under licenses issued by the governor. (See Licenses.)

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[8] *Alaska:* Game animals or birds may be killed at any time for food or clothing by native Indians or Eskimos, or by miners or explorers in need of food, but game so killed may not be shipped or sold.

ARIZONA.

Open seasons:[9]	*Dates inclusive.*
Deer (male), wild turkey	Oct. 1–Nov. 1.
Quail (except bobwhite)	Oct. 15–Dec. 31.
Mourning dove	Sept. 1–Dec. 15.
White-winged dove	July 15–Dec. 31.
Duck, goose, brant, Wilson snipe, coot, gallinule	Oct. 16–Jan. 31.
Black-bellied and golden plovers, yellowlegs	Oct. 15–Dec. 15.
Rail, other than coot and gallinule	Oct. 15–Nov. 30.

No open season: Does, spotted fawns, elk, antelope, sheep, goat, bobwhite, grouse, pheasant, swans, bitterns, little brown and sandhill cranes, grebes, gulls, herons, loons, band-tailed pigeon, terns, and all shorebirds (except Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses: Nonresident or alien: Game and fish, $20; birds (except turkeys) and fish, $10. Not issued to applicant under 12 years of age. Resident: Game and fish, $1.25. Issued by game warden, designated deputies, and clerk, board of supervisors

American-born resident under 17 years of age may hunt without a license, if accompanied by a holder of a general license.

Bag limits and possession: One deer, 2 turkeys a season; 20 ducks, 8 geese, 20 coots, 15 plovers and yellowlegs, and 20 rail, but not more than 20 in all of waterfowl, plovers, yellowlegs, rails, and coots a day or in possession; 25 quail, and 25 doves and white wings a day or in possession; 25 Wilson snipe a day. Possession of plovers, yellowlegs, rails, and mourning doves permitted during first 10 days of close season; other game during first five days thereof.

Sale: Sale of all protected game prohibited.

Export: Export of all protected game prohibited, except for scientific or propagating purposes under permit from State warden.

ARKANSAS.

Open seasons:	*Dates inclusive.*
Deer (buck) (see exception), bear	Nov. 10–Jan. 15.
Exception: Deer in Poinsett County, Nov. 10–Dec. 1.	
Squirrel	May 15–Jan. 15.
Turkey gobblers (see exception)	Nov. 10–Jan. 15. Mar. 1–May 1.
Exception: Turkey in Poinsett County, Nov. 10–Dec. 1.	
Quail (partridge) (see exceptions)	Nov. 20–Feb. 1.
Exceptions: Baxter and Boone Counties, Dec. 20–Feb. 1. In Charleston District, Franklin County (after Dec. 1) no open season.	
Duck, goose, Wilson snipe, coot, gallinule	Nov. 1–Jan. 31.
Woodcock	Nov. 1–Dec. 31.
Black-bellied and golden plovers, yellowlegs, dove	Sept. 1–Dec. 15.
Rail, other than coot and gallinule	Sept. 1–Nov. 30.

No open season: Does, fawns, wild turkey hens, pheasant, grouse, prairie chicken (1922); swans, wood duck, bitterns, sandhill and whooping cranes, grebes, gulls, herons, loons, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting licenses:[10] Nonresident for deer, bear, and turkey, $15; resident, $1.10. For dog in hunting, $1.50. Issued by State game and fish commission and circuit clerks. No license required of citizen to hunt or fish during open season on own premises. Hunting prohibited on inclosed lands without consent of owner. Scott County: Nonresident, game, $25, fish, $25; issued by circuit clerk.

Bag limits and possession: Two deer, 1 bear, 4 turkeys a season; 15 squirrels, 20 quail (40 in possession); 25 doves, 25 ducks (50 in possession); 8 geese, 8 brant, 25 Wilson snipe, 6 woodcock, 15 in all of plovers and yellowlegs, 25 in all of rails, coots, and gallinules a day or in possession. Possession of game permitted during first 10 days of close season.

Sale: Sale prohibited of all protected game (except squirrels).

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[9] *Arizona:* Animals or birds (except migratory birds) which become seriously injurious to agriculture or other interests may be killed under regulations of the State game warden.

[10] *Arkansas:* Fishing licenses to use artificial bait: Resident, $1.10; nonresident, general, $5; special 15-day (trip) license, $1.10.

Export: Export of all game prohibited; provided, a nonresident, under his license and affidavit that game was legally taken by himself and is not for sale, may take with him one day's bag limit. Commission may permit game to be shipped from the State for propagation.

CALIFORNIA.[11]

Open seasons:	*Dates inclusive.*
Male deer (except spike bucks), in districts 1, 1½, 4½, 23, 24, 25, and 26	Sept. 1–Oct. 15.
In districts 2, 2½, and 3	Aug. 1–Sept. 14.
In district 4	Sept. 16–Oct. 15.
Bear (black, brown)	Oct. 15–Mar. 1.
Tree squirrel	Sept. 1–Dec. 31.
Cottontail and brush rabbits,[12] mountain, valley, and desert quail (see exceptions)	Nov. 1–Jan. 15.
Exceptions: Mountain and valley quail, district 1½	Oct. 15–Dec. 15.
Grouse	Sept. 15–Oct. 14.
Sage hen (except in district 4½, no open season)	Aug. 1–Sept. 15.
Dove	Sept. 1–Oct. 31.
Duck, goose, brant, Wilson snipe or jacksnipe, coot (mudhen), gallinule	Oct. 1–Jan. 15.

No open season: Doe, spike buck, fawn, elk, antelope, sheep, pheasant, introduced quail or partridge, turkey, rail, plover, yellowleg, swans, wood duck, eider ducks, auklets, bitterns, little brown and sandhill cranes, fulmars, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, band-tailed pigeon, puffins, shearwaters, terns, and all shorebirds (except Wilson snipe or jacksnipe).

Hunting licenses:[13] Nonresident, $10; alien, $25 (except those with first papers, fee $10); resident, $1; veterans of Civil War, free of charge. Issued by commissioners and county clerks. Unlawful to hunt in inclosure of another without permission of owner.

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[11] *California:* Of the 59 fish and game districts created under the act of 1917, as amended in 1919 and 1921, 7 (1, 1½, 2, 2½, 3, 4, and 4½) are properly hunting districts; 23, 24, 25, and 26 are fishing districts, but are open to hunting; of the other 48 districts 26 are game refuges and 22 are fishing districts.

District 1 comprises the northern part of the State, the Sierras, and the east half of the Sacramento and San Joaquin Valleys, including all counties not included in districts 1½, 2, 2½, 3, 4, and 4½.

District 1½ comprises the counties of Del Norte, Siskiyou, and Humboldt.

District 2 comprises that part of the State south of Humboldt and Tehama Counties, west of the Sacramento River and north of San Francisco Bay, including the counties of Glenn, Colusa, Yolo, Solano, Napa, Lake, Sonoma, and Marin, and that portion of Mendocino County not included in District 2½.

District 2½ comprises that portion of Mendocino County lying west of divide between Eel and Russian River systems and Pacific Ocean, and not included in District 7.

District 3 comprises the region around the southern portion of San Francisco Bay and the coast counties south of the Golden Gate as far as Ventura, including the counties of Contra Costa, Alameda, Santa Clara, San Francisco, Santa Cruz, Monterey, San Luis Obispo, Santa Barbara, and Ventura; also San Benito and the west half of San Joaquin, Stanislaus, Merced, Fresno, and Kern Counties.

District 4 comprises the counties in southern California, namely, Los Angeles, Orange, Riverside, San Diego, Imperial, and San Bernardino.

District 4½ comprises the counties of Mono and Inyo.

Districts 23, 24, 25, and 26, all located in district No. 1, are as follows:

District 23 comprises the drainage area of Lake Tahoe and the Truckee River in the counties of Placer and Eldorado.

District 24 comprises the drainage area of Silver, Twin, Blue, Meadow, and Wood Lakes in the counties of Alpine and Amador.

District 25 comprises the drainage area of Lake Almanor in the counties of Plumas and Lassen.

District 26 comprises Sixty Lake Basin, part of Rae Lake, and to the south fork of Woods Creek, in Fresno County.

[12] Owner or tenant, or person holding written permission from owner or tenant, may kill rabbits on own premises at any time, but rabbits killed in close season may not be shipped or sold.

[13] Fishing licenses required of persons 18 years of age and over: Nonresident or alien, $3; resident, $1.

Bag limits and possession: Two deer, 12 tree squirrels a season; 15 cottontail or brush rabbits a day or 30 a week; 4 grouse a day or 8 a week; 4 sage hens a day or 8 a week; 10 mountain quail a day or 20 a week; 15 valley or desert quail a day or 30 a week; 25 Wilson snipe or jacksnipe a day or 50 a week; 15 mourning doves a day or 30 a week; 25 ducks and 8 geese a day or 50 a week combined; 8 honkers or black sea brant a day or 24 a week; 25 coots (mudhens) and gallinules a day, 50 coots a week.

Possession in excess of daily limit prohibited. Persons killing deer must retain in possession during open season and 10 days thereafter the skin and the portion of head bearing horns. One day's limit of game birds or animals may be possessed during first five days of close season.

Sale: Sale of deer meat and hides, tree squirrels, and all game birds prohibited.

Hides of deer taken in a foreign country may be sold. Cottontail and brush rabbits taken during open season may be sold. Domesticated reindeer may be imported and sold under regulations of fish and game commission.

Export: Export of all protected game prohibited, except for scientific or propagating purposes under permit from board of fish and game commissioners. All shipment by parcel post prohibited.

COLORADO.

Open seasons:	*Dates inclusive.*
Deer (having horns with two or more prongs on each horn)	Oct. 12–Oct. 15.
Rabbit, hare	Unprotected.
Prairie chicken, mountain and willow grouse	Sept. 15–Oct. 1.
Duck, goose, brant, coot, gallinule, Wilson snipe or jacksnipe, black-bellied and golden plovers, yellowlegs	Sept. 16–Dec. 31.
Sora and other rail (except coot and gallinule)	Sept. 1–Nov. 30.

No open season: Elk, antelope, sheep, does, fawns (1930); quail (bob-white and crested), pheasant, sage chicken, dove (1924); doe, partridge, ptarmigan, wild turkey, swans, wood duck, eider ducks, bitterns, little brown, sandhill, and whooping cranes, grebes, gulls, herons, jaegers, loons, band-tailed pigeon, terns, and all shorebirds (except Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses: Nonresident: Big game, $25; small game, $5; fish, $5. Resident: Big game, $3; small game and fish, $1. No person under 18 permitted to hunt big game. Fishing license not required of boys under 16 or of women. Children under 12 not permitted to hunt except on own premises or those of parent or guardian. Guide, $5. Issued by commissioner, county clerks, and other agents. Unlawful to hunt in any inclosure not public land without consent of owner. Unlawful to shoot game from public highway.

Unnaturalized foreign-born residents not permitted to hunt.

Bag limits and possession: One deer a season, coupon required; prairie chicken, 15 a day or in possession; mountain and willow grouse, 5 in all a day or in possession; 15 ducks, 8 geese, 8 brant, 25 Wilson snipe, 50 sora, 15 in all of other rails, coots, and gallinules, 15 in all of plovers and yellowlegs a day or in possession. Persons under 12 years of age limited to half this number of birds. Possession permitted during first 5 days of close season. Commissioner may issue permit authorizing storage, possession, and use of game for 90 days after close of open season (except possession of migratory birds limited to 10 days after close of season).

Sale: Sale of all game taken in State prohibited. Imported game (except migratory birds) may be sold under license by indorsement of shipping invoice to purchaser.

Export: The export of all protected game is prohibited; provided, birds, not exceeding the numbers allowed in possession, may be exported under permit from game commissioner (fee 25 cents for each bird) if permit be attached and packages plainly marked so as to show nature of contents, but not more than 2 days' limit of migratory birds shall be exported in any one calendar week; edible portion of deer may be exported under $5 permit from the commissioner.

CONNECTICUT.

(Laws of 1921 not received.)

Open seasons:

	Dates inclusive.
Deer.[14]	
Hare, rabbit (except Belgian or German hare, unprotected)	Oct. 8–Dec. 14.[15]
Gray squirrel, quail, ruffed grouse, pheasant (introduced), Hungarian partridge, woodcock	Oct. 8–Nov. 23.
Duck, goose, brant	Oct. 1–Jan. 15.
Coot (mudhen), gallinule	Oct. 1–Dec. 31.
Black-bellied and golden plovers, yellowlegs	Sept. 1–Nov. 30.
Wilson or English snipe	Oct. 1–Nov. 30.
Rail, other than coot and gallinule	Sept. 12–Nov. 30.

No open season: Dove, swans, wood duck, eider ducks, auks, bitterns, fulmars, gannet, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, shearwaters, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses: Nonresident: Game, $10.25; fish, $2.25.[16] Alien, $15.25. Resident citizen, $1.25. Not issued to persons under 16. Issued by city or borough clerk. No license required of resident and his children to hunt during open season on land on which he is actually domiciled if land is not used for club or shooting purposes.

Bag limits and possession: Six gray squirrels a day, 30 a season; 3 rabbits a day, 30 a season; 5 each of quail and woodcock a day, 36 each a season; 3 ruffed grouse a day, 21 a season; 3 Hungarian partridges a day, 21 a season; 2 pheasants a day, 15 a season; 25 in all of ducks, geese, and brant, but not exceeding 8 geese and 8 brant a day; 10 in all of plover, yellowlegs, and Wilson snipe; 35 sora and 25 in all of other rails, coot, and gallinules a day, but not more than 35 in all of sora and other rails. Possession of rails permitted during first 10 days of close season.

Sale: Sale of squirrels, rabbits, and introduced pheasant permitted during open season. Sale of other game prohibited.

Export: Export of quail, ruffed grouse, and woodcock prohibited; provided, a nonresident licensee under permit may take out in his immediate possession game lawfully killed, when duly tagged, if not for sale; but not more than two days' limit of migratory birds shall be exported in any one calendar week.

DELAWARE.

Open seasons:[17]

	Dates inclusive.
Rabbit, hare, quail, partridge, woodcock	Nov. 15–Dec. 31.
Squirrel (fox, black, gray)	Sept. 1–Oct. 15.
Dove (except in Newcastle County, no open season)	Sept. 1–Dec. 15.
Duck, goose, brant, Wilson snipe or jacksnipe, coot, gallinule	Oct. 16–Jan. 31.
Black-bellied and golden plovers, yellowlegs	Aug. 16–Nov. 30.
Rail, other than coot and gallinule	Sept. 1–Nov. 1.
Reedbird	Sept. 1–Oct. 30.[18]

No open season: Hungarian partridge or pheasant, swans, wood duck, eider ducks, bitterns, sandhill crane, grebes, gulls, herons, loons, murres, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses: Nonresident: Game, $10.50; fish, $3.50 (not good in Delaware River or Bay). Issued by commission. Unlawful to hunt on land of another without permission from owner or occupant. Fishing license not required of certain excursionists. Nonresidents who own or lease property at seaside summer resorts and their relatives, friends, and patrons sojourning at such resorts may fish for non-game fish and hunt without license during open season, between June 1 and September 30.

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[14] *Connecticut:* Owner of agricultural lands, member of family, or employee may kill deer with a shotgun at any time on such lands when damaging fruit trees or growing crops, but such killing or wounding must be reported to the commissioners within 12 hours.

[15] Between Nov. 24 and Dec. 15 hunting rabbits is permitted with dog and ferret only.

[16] Required only of residents of States which require a nonresident to obtain an angling license. Not required of nonresident taxpayer or member of his family, nor of persons under 16 years of age.

[17] *Delaware:* Minors under 15 years of age not permitted to hunt game with shotgun or rifle unless accompanied by an adult lawfully hunting.

[18] See order of Secretary of Agriculture, p. 73.

Bag limits and possession: Six in all of rabbits, hares, and squirrels, 20 ducks, 8 geese, 8 brant, 15 in all of plovers and yellowlegs, 25 Wilson snipe, 6 woodcock, 50 sora, 25 in all of other rails, coots, and gallinules, but not more than 50 in all of sora and other rails combined; 12 birds of any other species (except reedbirds) a day. Possession of migratory birds permitted during first 10 days of close season; other game during first 5 days thereof.

Sale: Sale of reedbirds and all protected game prohibited; provided, a resident may sell in his own county 20 rabbits a season, lawfully taken by him. Imported rabbits may be sold from November 15 to December 31.

Export: Export of rabbit, squirrel, quail, partridge, dove, woodcock, goose, and brant is prohibited; provided, holder of license may export, open to view, 10 rabbits, 10 squirrels, 50 rails, and 20 birds or fowl of any other species a week, lawfully killed by himself, under affidavit that the game is not for sale. Resident may export ducks, snipe, and plover. In no event, however, shall a person export more than 2 days' limit of migratory birds in any one calendar week. Under permit (fee, $1) of board, 10 pairs of any one species of game or birds may be captured or transported.

DISTRICT OF COLUMBIA.[19]

Open seasons:	*Dates inclusive.*
Deer meat (sale or possession)	Sept. 1–Jan. 1.
Rabbit (except English rabbit, Belgian hare), squirrel	Nov. 1–Feb. 1.
Marsh blackbird	Sept. 1–Feb. 1.
Duck, goose, brant, Wilson snipe, coot, gallinule	Nov. 1–Jan. 31.
Black-bellied and golden plovers, yellowlegs, rail or ortolan	Sept. 1–Nov. 30.
Woodcock	Nov. 1–Dec. 31.
Reedbird	Sept. 1–Oct. 30.[20]

No open season: Dove, swans, wood duck, bitterns, grebes, gulls, herons, loons, murres, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Bag limits and possession: Twenty-five ducks, 8 geese, 8 brant, 25 Wilson snipe, 6 woodcock, 50 sora, 25 in all of other rails, coots, and gallinules, 15 in all of plovers and yellowlegs a day. Possession of migratory birds permitted during first 10 days of close season; quail, November 1 to March 15; ruffed grouse or pheasant (except English or other imported pheasants raised in inclosures, possession unrestricted) and wild turkey, November 1 to December 26; prairie chicken (pinnated grouse), September 1 to March 15.

Sale: Sale of all game birds prohibited; provided, Hungarian partridge, English, ring-neck, Mongolian, or Chinese pheasants raised in captivity may be sold at any time. Deer, rabbit, and squirrel may be sold during open season.

Export: Export of migratory game birds in excess of two days' bag limit in any one calendar week prohibited.

FLORIDA.

Open seasons:	*Dates inclusive.*
Deer, squirrel (see exceptions), quail (bobwhite partridge), wild turkey	Nov. 20–Feb. 15.
Exceptions: Squirrels in Escambia County	Oct. 15–Mar. 1.
Squirrels in Holmes and Walton Counties	Oct. 20–Mar. 1.
Ruffed grouse, imported pheasants (see exception)	Nov. 20–Dec. 19.
Exception: English pheasant in Escambia County, no open season.	
Duck, goose, brant, black-bellied and golden plovers, Wilson snipe, yellowlegs, coot, gallinule, dove	Nov. 20–Jan. 31.
Woodcock	Nov. 1–Dec. 31.
Rail, other than coot and gallinule	Nov. 20–Nov. 30.
Reedbird (ricebird)	Aug. 16–Nov. 15.[21]

No open season: All wild birds and animals (except opossum and skunk) protected on Pine Island, Lee County. Swans, wood duck, bitterns, sandhill and whooping cranes, gannet, grebes, gulls, herons, jaegers, loons, petrels, shearwaters, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

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[19] *District of Columbia:* Hunting prohibited in the District by act of June 30, 1906, except on the marshes of the Eastern Branch above Anacostia Bridge and below the Aqueduct Bridge on the Virginia side of the Potomac, but in these areas no birds may be shot within 200 yards of any bridge or dwelling.

[20] See order of Secretary of Agriculture, p. 73.

[21] *Florida:* See order of Secretary of Agriculture, p. 73.

Hunting licenses: Nonresident or alien (county license), $25; resident, $1.25 (county of residence); resident, $3.50 (county other than county of residence). License not required in voting precinct nor of Confederate veteran entitled to a State pension. Issued by county judge.

Bag limits and possession: Two deer, 5 turkeys, and 300 of any other game birds a year; 1 deer, 2 turkeys, 20 quail, 25 ducks, 8 geese, 8 brant, 25 Wilson snipe, 6 woodcock, 25 in all of rails, coots, and gallinules, 15 in all of plovers and yellowlegs, and 25 doves a day. Camping or hunting party of 3 or more limited to 2 deer and 3 turkeys. Possession of migratory birds permitted during first 10 days of close season; other game during first 5 days thereof.

Sale: The sale of reedbirds (ricebirds) and all protected game is prohibited.

Export: Export of all protected game is prohibited, except nonresident licensee may carry out game as personal baggage, but not more than two days' limit of migratory game birds shall be exported in any one calendar week.

GEORGIA.

(Laws of 1921 not received.)

Open seasons:	*Dates inclusive.*
Deer	Oct. 1–Nov. 30.
Rabbit, fox squirrel	Unprotected.
Cat squirrel, opossum	Oct. 1–Feb. 28.
Quail, partridge, wild turkey gobblers	Nov. 20–Feb. 28.
Duck, goose, brant, coot, gallinule, Wilson snipe	Nov. 1–Jan. 31.
Black-bellied and golden plovers, yellowlegs, dove	Nov. 20–Jan. 31.
Woodcock	Nov. 1–Dec. 31.
Rail, other than coot and gallinule	Sept. 1–Nov. 30.
Reedbird (ricebird)	Aug. 16–Nov. 15.[22]

No open season: Fawn, grouse, pheasant, turkey hen, introduced game birds, swans, wood duck, eider ducks, bitterns, sandhill and whooping cranes, gannet, grebes, gulls, herons, loons, petrels, shearwaters, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting licenses: Nonresident, $15; resident, State $3, county $1 (good only in county of residence). License not required in militia district or to hunt on own or leased land. Issued by commissioner or county warden.

Bag limits and possession: Two deer, 2 turkeys a season; 15 cat squirrels, 25 ducks, 8 geese, 8 brant, 15 in all of plovers and yellowlegs, 25 Wilson snipe, 6 woodcock, 25 in all of rails, coot, and gallinules, 25 doves a day. Possession of migratory birds except woodcock permitted during first 10 days of close season.

Sale: Sale of reedbirds (ricebirds) and all protected game prohibited.

Export: Export of all protected game prohibited; provided, nonresident licensee may take out in personal possession game lawfully killed, but not more than 2 days' limit of migratory birds shall be exported in any one calendar week.

IDAHO.

Open seasons:[23]	*Dates inclusive.*
Elk in Bingham, Bonneville, Clark, Fremont, and Teton Counties	Nov. 15–Nov. 30.
Elk, mountain goat in Clearwater and Idaho Counties	Oct. 1–Nov. 15.
Deer, mountain goat in Adams, Boise, Bonneville, Butte, Camas, Clark, Elmore, Gooding, Jefferson, Lincoln, Madison, Power, and Teton Counties	Oct. 1–Nov. 30.
Deer in Benewah, Blaine, Bonner, Boundary, Clearwater, Custer, Idaho, Kootenai, Latah, Lemhi, Lewis, Nez Perce, Shoshone, and Valley Counties	Oct. 1–Nov. 15.
In Bear Lake, Franklin, and Oneida Counties	Oct. 15–Nov. 1.
Bear in Benewah, Bonner, Boundary, Kootenai, and Shoshone Counties	Sept. 16–May 30.
In rest of State	Unprotected.
Quail in Ada, Canyon, Gem, Gooding, and Kootenai Counties	Nov. 1–Nov. 15.
In Nez Perce County	Nov. 1–Nov. 30.
Sage hen in State (except Franklin County, no open season)	Aug. 15–Sept. 15.
Chinese, ringneck, and Mongolian pheasants in Ada, Canyon, Gem, Owyhee, Payette, and Washington Counties	Nov. 1–Nov. 15.
In Gooding, Jerome, Latah, Lincoln, Nez Perce, and Twin Falls Counties	Nov 1–Nov. 30.

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[22] *Georgia:* See order of Secretary of Agriculture, p. 73.

[23] *Idaho:* State warden may close season in any county or part thereof on any species of game which is threatened with extinction.

Open seasons—Continued.	*Dates inclusive.*
Grouse in Benewah, Bonner, Boundary, Kootenai, and Shoshone Counties	Oct. 1–Oct. 31.
In Clearwater, Idaho, Latah, Lewis, and Nez Perce Counties	Sept. 15–Oct. 15.
Ruffed grouse in Bannock, Bear Lake, Bingham, Bonneville, Butte, Caribou, Franklin, Fremont, Jefferson, Madison, Oneida, Power, and Teton Counties	Aug. 15–Sept. 15.
Blue or dusky grouse in Adams, Bannock, Bingham, Boise, Bonneville, Butte, Camas, Elmore, Fremont, Gem, Idaho, Lemhi, Madison, Teton, Valley, and Washington Counties	Aug. 15–Sept. 30.
In Bear Lake, Franklin, and Oneida Counties	Sept. 1–Sept. 30.
Hungarian partridge in Kootenai and Latah Counties	Nov. 1–Nov. 15.
In Nez Perce County	Nov. 1–Nov. 30.
Duck, goose, brant, Wilson snipe or jacksnipe, black-bellied and golden plovers, yellowlegs, coot, and gallinules	Oct. 1–Dec. 31.
Rail, other than coot and gallinule	Sept. 1–Nov. 30.

No open season: Deer, elk, mountain goat (except as above), moose, antelope, caribou, sheep, buffalo, fawn, calf elk, prairie chicken, grouse (except as above), and imported pheasants (except Chinese, ringneck, and Mongolian pheasants as above), mourning dove, swans, wood duck, bitterns, little brown and sandhill cranes, grebes, gulls, herons, loons, terns and all shore birds (except Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses: Nonresident:[24] Game and fish, $25; bird, $5; fish, $3. Alien: Game and fish, $50; fish, $10; gun license, $5. Resident: Game and fish, $2. Issued by warden, deputy, or authorized agent. Hunting license not issued to minor under 12 years. Fishing license not required of children under 12. No license required of veterans of Civil War. Persons under 12 prohibited from possessing gun afield.

Bag limits and possession: One deer, 1 elk, 1 goat a season; 8 quail, 4 in all of Chinese, ringneck, and Mongolian pheasants; 6 in all of partridge, pheasant, grouse, Hungarian partridge, and 6 sage hens a day or in possession; 12 ducks, 2 geese, 6 black-bellied and golden plovers, 6 yellowlegs, 12 Wilson snipe, or a total of 20 in all a day or in possession; 50 sora and 25 in all of other rails, coots, and gallinules a day. When tagged with proper license tag, migratory waterfowl may be stored by owner, under affidavit and storage permit, during open season and 10 days thereafter.

Sale: Sale of all protected game (except bear) prohibited. Hides, heads, and horns may be sold under permit.

Export: Export of all protected game is prohibited; provided, any hunter may export, under hunting license coupon, big game lawfully taken; big game once shipped within State may be exported under a 50-cent permit obtained from game warden or deputy. Mounted heads and stuffed birds legally secured may be exported under a reshipping permit.

ILLINOIS.

Open seasons:	*Dates inclusive.*
Rabbit	Nov. 1–Jan. 31.
Squirrel	July 1–Dec. 1.
Quail (bob-white)	Nov. 10–Dec. 10.
Prairie chicken	Oct. 20–Oct. 31.
Introduced pheasant (cocks)	Oct. 1–Oct. 5.
Dove	Sept. 1–Sept. 30.
Duck, goose, brant, Wilson snipe, coot, gallinule, black-bellied and golden plovers, yellowlegs	Sept. 16–Dec. 31.
Rail, other than coot and gallinule	Sept. 1–Nov. 30.

No open season: Deer (1925); wild turkey, introduced pheasant hen, sand grouse (1925); ruffed grouse (partridge), blue, mountain, and valley quail, Hungarian partridge, capercailzie, heath hen, black grouse, woodcock (1923), swans, wood duck, eider ducks, bitterns, little brown, sandhill, and whooping cranes, grebes, gulls, herons, jaegers, loons, murres, petrels, terns, and all shorebirds (except Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting licenses: Nonresident, $10.50; resident, $1. Licenses not issued to aliens, nor to minors under 16 without written consent of parent or guardian. Issued by village, county, or city clerk. Owners, their children, and tenants in actual residence may hunt during open season on own land without license. Permission required to hunt on lands of another.

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[24] *Idaho:* Residents of adjoining States having larger nonresident license fee for big game hunting must pay fee charged in own State.

Bag limits and possession: Ten squirrels, 15 rabbits, 12 quail, 3 prairie chickens, 2 cock pheasants, 15 doves, 15 in all of black-bellied and golden plovers and yellowlegs, 15 snipe, 15 in all of coot and gallinules, 15 rail, but not more than 25 in all of rails, coots, and gallinules, 15 ducks, 8 geese, 8 brant a day. Limit in possession, 20 squirrels, 36 quail, 12 prairie chickens, 6 cock pheasants, 25 doves, 50 black-bellied and golden plovers and yellowlegs, 50 snipe, 60 coots and gallinules, 60 rail, 60 ducks, 10 geese, 10 brant.

Sale: Sale of all protected game (except rabbit during open season) prohibited.

Export: Export of all protected game (except rabbit) prohibited, except nonresident licensee may take from State 50 game birds or animals, if carried openly for inspection, but not more than 2 days' limit of migratory birds shall be exported in any one calendar week.

Holder of certificate may ship birds and game at any time for scientific or propagating purposes. (See Regulations 8 and 9, pp. 70–72.)

INDIANA.

Open seasons:	*Dates inclusive.*
Rabbit	Apr. 1–Jan. 10.
Squirrel	Aug. 1–Dec. 1.
Quail, ruffed grouse	Nov. 10–Dec. 20.
Prairie chicken	Oct. 15–Nov. 1.
Duck, goose, brant	Sept. 16–Dec. 31.
Woodcock	Oct. 1–Nov. 30.
Black-bellied and golden plovers, yellowlegs, Wilson snipe or jacksnipe, coot, gallinule	Sept. 16–Dec. 20.
Rail, other than coot and gallinule	Sept. 1–Nov. 30.

No open season: Deer, Hungarian partridge, introduced pheasant, wild turkey, dove, swans, wood duck, bitterns, sandhill and whooping cranes, gannet, grebes, gulls, herons, jaegers, loons, murres, petrels, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses: Nonresident: Game and fish, $15.50; fish, $1. Resident: game and fish, $1. Issued by clerk circuit court. Not issued to person under 14 without written consent of parent or guardian. Honorably discharged soldiers, sailors, and marines, and those in the regular service who are residents of the State require no license to hunt and fish; owners of farm land, their children living with them, and tenants may hunt during open season on own land without a license. No license required of persons to fish in county of residence or contiguous counties. All children under 18 and wife of licensee may fish without license.

Bag limits and possession: Fifteen quail, 5 prairie chickens, 15 ducks, 8 geese, 8 brant a day; 45 quail or waterfowl in possession as result of 3 or more days' consecutive hunting; 25 Wilson snipe, 6 woodcock, 50 sora, and 25 in all of other rails, coots, and gallinules, and 15 in all of plovers and yellowlegs a day. Possession of waterfowl permitted during first 10 days of close season.

Sale: Sale of quail, prairie chicken, introduced pheasants, Hungarian partridges, and migratory birds prohibited.

Export: Export of deer, quail, grouse, prairie chicken, pheasant, wild turkey, woodcock, duck, goose, brant, and other waterfowl prohibited, except nonresident may take from State 15 birds killed by himself (or 45 if he has hunted for 3 or more days consecutively) if carried openly for inspection together with license, but not more than two days' limit of migratory birds shall be exported in any one calendar week.

Miscellaneous: Shooting on highways or with searchlight prohibited.

IOWA.

Open seasons:	*Dates inclusive.*
Squirrel (gray, timber, or fox)	Sept. 1–Jan. 1.
Ruffed grouse or pheasant, wild turkey	Nov. 1–Dec. 15.
Duck, goose, brant, Wilson snipe or jacksnipe, coot, gallinule, black-bellied and golden plovers, yellowlegs	Sept. 16–Dec. 31.
Woodcock	Oct. 1–Nov. 30.
Rail, other than coot and gallinule	Sept. 1–Nov. 30.

No open season: Deer, elk, quail, prairie chicken, introduced pheasants, Hungarian partridge (1927); turtle dove, swans, wood duck, eider ducks, bitterns, little brown, sandhill, and whooping cranes, grebes, gulls, herons, jaegers, loons, murres, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses: Nonresident or alien, game, $10; nonresident, fish, $2 (required of males over 16 years of age. Resident citizen, $1. Issued by county auditor. License not granted to persons under 18 without written consent of parent or guardian. Owners of farm lands, their children, and tenants, may hunt on own lands during open season without license. Unlawful to hunt on cultivated or inclosed lands of another without permission from owner.

Bag limits and possession: Twenty-five ducks a day, 50 in possession; 8 geese, 8 brant, 15 in all of plovers and yellowlegs, 25 Wilson snipe, 6 woodcock, 25 in all of rails, coots, and gallinules a day, 25 of each in possession. Twenty-five each of other birds and game a day or in possession. Possession of migratory birds permitted during first 10 days of close season; other game during first 5 days thereof.

Sale: Sale of all protected game prohibited.

Export: Export of all protected game prohibited, except nonresident may take from State not more than 25 game birds or animals, if carried openly for inspection, and if hunting license be shown on request, but not more than two days' limit of migratory birds shall be exported in any one calendar week.

KANSAS.

Open seasons:	*Dates inclusive.*
Fox squirrel	Aug. 1–Jan. 1.
Quail	No open season.[25]
Prairie chicken	Sept. 20–Sept. 30.
Dove	Sept. 1–Oct. 15.
Duck, goose, brant, Wilson snipe, coot, gallinule, black-bellied and golden plovers, yellowlegs	Sept. 16–Dec. 31.
Rail, other than coot and gallinule	Sept. 1–Nov. 30.

No open season: Deer, antelope (1925); red, gray, and black squirrels, ruffed grouse (partridge), pheasant (English, Mongolian, Hungarian); woodcock, swans, wood duck, eider ducks, bitterns, little brown, sandhill, and whooping cranes, grebes, gulls, herons, loons, terns, and all shorebirds (except Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting licenses: Nonresident, $15. Issued by secretary of state. Resident, $1. Issued by county clerk. Resident landowner or member of family may hunt on own land during open season without a license. Unlawful to hunt on land of another or on highway or railroad right of way adjacent thereto without consent of owner, unless accompanied by him. Alien not permitted to hunt.

Bag limits and possession: Twenty-five in all of ducks, coots, and gallinules; 20 doves, 5 prairie chickens, 5 in all of geese and brant, 6 rails, and 15 in all of Wilson snipe, plovers, and yellowlegs a day. Possession permitted during first 5 days of close season.

Sale: Sale of all protected game birds prohibited.

Export: Export of all protected game birds prohibited, except that a person may carry or transport, open to view, and in his personal possession, not more than 2 days' limit of 2 kinds of game, legally taken by himself.

KENTUCKY.

Open seasons:	*Dates inclusive.*
Rabbit [26]	Nov. 15–Dec. 31.
Squirrel	July 1–Dec. 15.
Quail, ruffed grouse (native pheasant)	Nov. 15–Jan. 1.
Dove	Sept. 1–Dec. 15.
Woodcock	Nov. 15–Nov. 30.
Duck, goose, brant, Wilson snipe or jacksnipe, coot, gallinule, black-bellied and golden plovers, yellowlegs	Sept. 16–Dec. 31.
Rail, other than coot and gallinule	Sept. 1–Nov. 30.

No open season: Deer, elk (1925); introduced pheasants, Hungarian partridge, wild turkey (1924); swans, wood duck, bitterns, sandhill and whooping cranes, grebes, gulls, herons, jaegers, loons, petrels, terns, and all shorebirds (except woodcock, Wilson snipe, black-bellied and golden plovers, and yellowlegs).

Hunting licenses: Nonresident or alien, $7.50. Resident, $1. Issued by county clerk. Resident landowner, tenant, and members of families may hunt on own land during open season without license. Unlawful to enter inclosed lands of another for shooting, hunting, or fishing without consent.

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[25] *Kansas:* The season on quail is closed in odd years, 1921, 1923, etc.

[26] *Kentucky:* Rabbits may be taken with dogs or traps at any time for a person's own use on own land, but not for sale or barter.

Bag limits and possession: Twelve quail a day, 12 in possession for each successive day of hunt; 15 doves a day, 15 in possession for each successive day of hunt; 2 ruffed grouse a day; 25 ducks, 8 geese, 8 brant, 6 woodcock, 15 in all of plovers and yellowlegs, 25 Wilson snipe, and 25 in all of other rails, coot, and gallinules a day.

Sale: Sale of quail, partridge, grouse, introduced or native pheasant, Hungarian partridge, wild turkey, and migratory birds, wherever killed, prohibited.

Export: Export of deer, elk, and all game birds prohibited, except a hunter may transport game lawfully killed and possessed by him, but more than 2 days' limit of migratory birds shall not be exported in any one calendar week.

LOUISIANA.

Open seasons:	*Dates inclusive.*
Deer (see exception)	Oct 1–Jan. 15.[27]
Exception: In Beauregard, Allen, Rapides, La Salle, Winn, Jackson, Lincoln, Union, and in all parishes north and west thereof	Sept. 16–Dec. 31.
Bear	Nov. 1–Feb. 15.[28]
Squirrel, chipmunk	Oct. 1–Mar. 1.
Hare, rabbit	July 1–Feb. 28.
Dove	Oct. 16–Jan. 31.
Quail, wild turkey (gobblers, Nov. 15–Apr. 1)	Nov. 15–Feb. 15.
Gros-bec (night heron)	July 1–Nov. 1.
Duck, goose, brant, black-bellied and golden plovers, Wilson snipe, yellowlegs, rail, coot, gallinule	Nov. 1–Jan. 31.

No open season: Fawns, elk, prairie chicken, introduced pheasant, upland plover (papabotte) (1922); woodcock (1923); swans, wood duck, bittern, sandhill and whooping cranes, gannet, grebes, gulls, herons, loons, petrels, terns, and all shorebirds (except Wilson snipe or jacksnipe, black-bellied and golden plover, and yellowlegs).

Hunting licenses: Nonresident or alien, $15; resident, $1. Issued by tax collectors. Nonresident or alien not permitted to hunt for profit. A person may hunt during open season without a license on land owned or leased for agricultural purposes. License does not authorize hunting on land of another without his written consent.

Bag limits and possession: Two deer a day or in possession, 5 a season; 15 squirrels and chipmunks, 15 quail, 1 turkey, 25 doves, 25 ducks; 8 geese, 8 brant, 10 in all; 25 in all of rails, coots, and gallinules; 15 gros-becs; 15 in all of plovers and yellowlegs; 25 Wilson snipe and 15 other birds in all a day. Possession permitted during first five days of close season.

Sale: Sale of all game (except squirrels and rabbits during open season) prohibited.

Export: Export of all protected game prohibited, except under permit for scientific or educational purposes; provided, a nonresident licensee may carry with him out of the State under his license one day's limit of game, if not for sale; the head, hide, feet, or fur of wild quadrupeds, and plumage or skin of birds legally taken may be exported if contained in a package properly marked. All game and all packages containing game must be tagged to show kind and number, names of consignor and consignee, initial point of billing, and destination. Bears may not be exported, except under written permission of conservation department.

MAINE.[29]

Open seasons:[30]	*Dates inclusive.*
Deer (see exceptions)	Oct. 1–Nov. 30.
Exceptions: In Hancock and Washington Counties	Oct. 15–Dec. 14.[31]
In Androscoggin, Cumberland, Kennebec, Knox, Lincoln, Sagadahoc, Waldo, and York Counties	Nov. 1–Nov. 30.

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[27] *Louisiana:* Deer season fixed by conservation commissioner.

[28] Nonresidents coming into State to hunt bears must report in writing to conservation department before arrival at destination.

[29] *Maine:* Commissioner may make local regulations and governor may suspend hunting seasons during drought.

[30] All hunting is prohibited on Kineo Point, Piscataquis County; on Prout's Neck, and on Richmonds Island, Cumberland County; southern point Swan Island; and locally in town of Eden, Hancock County, Cape Elizabeth, and town of Scarboro, Cumberland County. (See State laws for details and other protected areas.)

[31] Only residents of Hancock and Washington Counties are permitted to hunt deer therein from December 1 to December 14.

Open seasons—Continued.	*Dates inclusive.*
Hare, rabbit	Oct. 1–Mar. 31.
Gray squirrel	Oct. 1–Oct. 31.[32]
Ruffed grouse, partridge, woodcock	Oct. 1–Nov. 30.
Duck, goose, brant, Wilson snipe, coot, gallinule (see exception)	Sept. 16–Dec. 31.
Exception: Waterfowl, in Back Bay, Portland	No open season.
Black-bellied and golden plovers, yellowlegs (see exception)	Aug. 16–Nov. 30.
Exception: In Merrymeeting Bay and towns adjacent thereto	Sept. 16–Nov. 30.
Rail, other than coot and gallinule	Sept. 1–Nov. 30.

No open season: Moose (1925); deer on Cross, Scotch, Swan, and Mount Desert Islands, and in towns of Deer Isle, and Stonington, in Hancock County, in Isle au Haut, in Knox County, in Perkins, Sagadahoc County, and in York, York County; cow and calf moose, caribou, quail, Hungarian partridge, pheasant, black game, capercailzie, cock of the woods, dove, swans, wood duck, eider ducks, auks, bitterns, gannet, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses: Nonresident hunting licenses: Deer or other game (except moose), October 1–December 31, $15; birds, prior to October 1 in Aroostook, Franklin, Hancock, Oxford, Penobscot, Piscataquis, Somerset, and Washington Counties, $5; season (except November) in rest of State (8 southern counties), $5. For November (in southern counties), a $15 license is required. Holder of a license may exchange it for a license for which a larger fee is required by paying the difference in cost. Nonresident must be accompanied by registered guide when camping and kindling fires while hunting or fishing on wild lands (land in unorganized or unincorporated townships) prior to November 30. Nonresident fishing license, $3.15 (not required of children under 16 years of age); resident alien fishing license, $2.15. Resident alien, game, $15 (not required of aliens who pay taxes on real estate and who have resided in State two years continuously prior to application). Guide licenses: Nonresident, $20 (issued only to residents of adjoining States or Provinces); resident, $1. Must not guide more than five persons hunting at one time. Sporting camp, $5. Shipping licenses (within State): Resident, deer, $2; one pair of game birds in seven days, 50 cents. Issued by commissioner.

Resident hunting license, fee 25 cents. Not required of resident or member of immediate family for hunting during open season on own land used exclusively for agricultural purposes and on which he is actually domiciled. License valid as long as holder remains citizen of State. Issued by city, town, and plantation clerks.

Bag limits and possession: Two deer, one of which must be an antlered buck (except in Androscoggin, Cumberland, Kennebec, Knox, Lincoln, Sagadahoc, Waldo, and York Counties, collectively, limit 1), a season; 5 ruffed grouse a day, 25 a season; 10 ducks, 8 geese, 8 brant, 15 in all of plovers and yellowlegs but not more than 5 plovers, 10 Wilson snipe, 6 woodcock, and 25 in all of rails, coot, and gallinules a day. Transportation of migratory game birds must be completed within five days after close of season; reasonable time allowed after close of season to transport other game to home of owner. Possession of migratory birds limited to first 10 days of close season; deer legally secured may be possessed during close season.

Sale: Sale of all protected game birds prohibited; unlawful to sell or give away deer for export. Local provision dealer, under $5 license, may purchase 2 deer for retail to his customers. Deer skins and skins with heads attached may be bought and sold by residents under $25 license. Heads when detached from skins with which purchased may be sold to licensed taxidermists.

Export: Export of all protected game prohibited; provided, a resident of the State, under shipping license, may export 5 partridges, 6 woodcock, and 10 ducks (fee $5) lawfully killed by himself. A nonresident may export, open to view under hunting-license tags, 2 deer, 5 partridges, 10 ducks, and 6 woodcock, lawfully killed by himself, upon identifying same at shipping point; nonresident licensee may also ship out one pair of game birds a month under a special 50-cent license. Live game may be exported for breeding and advertising purposes under permit of the commissioner of inland fisheries and game.

Miscellaneous: Unlawful to possess rifle or shotgun, either loaded or with a cartridge in the magazine thereof in or on any motor vehicle while upon any highway or in the fields or forests.

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[32] Squirrels protected in parks and in compact or built-up portions of cities and villages.

MARYLAND.

Open seasons:	*Dates inclusive.*
Rabbit, squirrel, quail (partridge), ruffed grouse (pheasant), male introduced pheasant, wild turkey	Nov. 10–Jan. 1.
Woodcock	Nov. 10–Dec. 31.
Dove	Sept. 1–Dec. 15.
Duck, goose, brant, Wilson snipe, coot, gallinule	Nov. 1–Jan. 31[33]
Black-bellied and golden plovers, yellowlegs	Aug. 16–Nov. 30.[33]
Rail, other than coot and gallinule	Sept. 1–Nov. 1.
Reedbird	Sept. 1–Oct. 30.[34]

No open season: Deer, elk (1922); introduced pheasant hens, swans, wood duck, eider ducks, auks, bitterns, sandhill crane, gannet, grebes, gulls, herons, jaegers, loons, murres, petrels, shearwaters, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Sale: Sale of quail, ruffed grouse, wild turkey, introduced pheasant, and doves, reedbirds, and all other migratory game birds is prohibited.

Export: Export of all protected game (except waterfowl) prohibited; provided, a licensed hunter may take out under his license an amount equal to one day's bag limit of game, if not for sale; provided, further, no person may take out more than 50 ducks, 16 geese, and 16 brant in any one calendar week.

Hunting licenses: Nonresident, $10.25 (fee $5.10 for State license if applicant owns real estate in Maryland assessed at $500; $1.10 for county license in county where such real estate is located); resident, State, $5.10; county, $1.10; issued by clerks of circuit court—in Baltimore city by clerk, court of common pleas. License not issued to person under 14 years of age without written request of parent or guardian. Owners, tenants, and their children may hunt on own land during open season without license. Patuxent River Club license, $25; issued by clerk of circuit court.

Sinkbox, sneak boat, blind, pusher.—Cecil: Sneak boat (Bohemia and Elk Rivers), $5.50; sinkbox (Bohemia, Elk, and Sassafras Rivers), $10.50. *Anne Arundel:* Pusher, $2; booby and brush blinds (west side Chesapeake Bay), $5; (south River), $2.50. *Harford:* Sinkbox, $20.75; sneak boat, $5.75. *Kent:* Sinkbox, $20; blind, $5. *Queen Anne:* Sinkbox, $10.50; sneak boat, $5.75; booby blind, $2.50. *Susquehanna Flats:* Sinkbox, $20.75; sneak boat, $5.75. *Talbot:* Sinkbox or blind, $5 (issued to county resident only). *Patuxent River:* Pusher, $2.50 (required of residents to push or paddle nonresidents); blind, $5.25 (not required in St. Marys County).

Bag limits and possession: Four wild turkeys a season; 10 rabbits, 10 squirrels, 12 quail (partridge), 2 ruffed grouse, 3 English pheasants, 6 woodcock, 12 doves, 10 jacksnipe, 15 yellowlegs, 5 black-bellied plover, 15 golden plover (but not more than 15 plovers and yellowlegs combined), 50 reedbirds, 50 sora, 25 in all of other rails, coots, and gallinules (but not more than 10 coots and gallinules or 50 sora and other rails combined), 25 waterfowl (but not more than 8 geese and 8 brant) a day for each licensed gunner (not exceeding 4) connected with an outfit. Possession of waterfowl, Wilson snipe, and plovers permitted during first 10 days of close season, and of doves until December 24.

Additional county restrictions: Allegany, 2 wild turkeys a day. Garrett, 2 ruffed grouse, 3 English pheasants, 6 other game birds a day. Harford, 6 rabbits, 1 jack rabbit, 8 squirrels, 10 quail, 5 woodcock, a day or in possession.

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[33] *Maryland:* Wild fowl shooting restricted locally as follows: On the Susquehanna Flats north of a line extending from Turkey Point Lighthouse, Cecil County, and half a mile north of Spesutia Island to Oakington, Harford County, hunting allowed only on Mondays, Wednesdays, and Fridays, Nov. 1–Jan. 1, and Mondays, Wednesdays, Fridays, and Saturdays, Jan. 1–Jan 31; in Harford County only before 2 p. m.; in Anne Arundel County, on Magothy River on Tuesdays, Thursdays, and Saturdays; on Rhode and West Rivers on Mondays, Wednesdays, and Fridays; on Severn River on Mondays, Wednesdays, and Saturdays; in Cecil County, on Bohemia, Elk, and Sassafras Rivers on Mondays, Wednesdays, Fridays, and Saturdays; in Dorchester, County, on Choptank River on Tuesdays, Thursdays, and Saturdays; in Kent County, on Chester River above Cliff City and Spaniard Point on Mondays, Fridays, and Saturdays; in St. Marys County, on Wicomico River and tributaries on Tuesdays, Thursdays, and Saturdays.

[34] See Order of the Secretary of Agriculture, p. 73.

MASSACHUSETTS.

Open seasons:[35] *Dates inclusive.*

Deer (from sunrise, first Monday in December to sunset the following Saturday, inclusive) .... Dec. 5–Dec. 10.

Hare (known as varying or Canada hare or snowshoe or white rabbit) or rabbit (see exceptions) .... Oct. 20–Jan. 31.

Exceptions: In Dukes and Nantucket Counties, Nov. 15–Feb. 15; European hares in Berkshire County, unprotected.

Gray squirrel, quail, ruffed grouse, pheasant (male), woodcock (see exception) .... Oct. 20–Nov. 20.

Exception: Quail in Dukes, Essex, Hampden, Middlesex, and Nantucket Counties (1922).

Duck, goose, brant, Wilson snipe, gallinule, quark (mudhen) .... Sept. 16–Dec. 31.

Black-bellied and golden plovers, yellowlegs .... Aug. 16–Nov. 30.

Rail, other than coot and gallinule .... Sept. 1–Nov. 30.

No open season: Moose, dove, prairie chicken, Hungarian partridge, pheasants (English, golden, Mongolian),[36] heath hen, swans, wood duck, eider ducks, auks, bitterns, sandhill and whooping cranes, fulmars, gannet, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing[37] **licenses:** Nonresident citizen: General, $10; fish, $1 (1922, $2). Members of incorporated game clubs owning real estate assessed at not less than $500 for each member, and which were organized prior to 1907; owners, or their minor children over 18 years old, of real estate assessed at not less than $500; or nonresidents invited (for not more than four days) by members of incorporated club for hunting foxes pay a fee of $1. Resident citizen: General, $1 (1922, $2); (1922, hunt and trap, $1.50); fish, 50 cents (1922, $1). License not issued to minors under 15, and those under 18 years of age must apply in writing and furnish written consent of parent or guardian. A license (fee 25 cents) to trap quadrupeds, in discretion of issuing officer, may be issued to any minor who is a citizen between the ages of 12 and 18. License not required of resident for hunting on own land used exclusively for agricultural purposes and on which he is actually domiciled, nor of women or minors under 18 to fish. Alien: General, $15: fish, $1 (1922, $2) (applicant must own real estate to the assessed value of $500). Issued by city or town clerks.

Bag limits and possession: One deer a season; 2 hares and 5 rabbits a day or in possession; 5 gray squirrels a day, 15 a season; 4 quail a day, 20 a season; 3 ruffed grouse a day, 15 a season; 2 pheasants a day, 6 a season; 4 woodcock a day, 20 a season; 25 ducks (not more than 15 black ducks), 8 geese, 8 brant, 15 in all of plovers and yellowlegs, 25 Wilson snipe, 50 sora, and 25 in all of other rails, coots, and gallinules a day. Possession of waterfowl in counties of Barnstable, Bristol, Dukes, and Nantucket, and of plovers, yellowlegs, and rails permitted during first 10 days of close season.

Sale: The sale of all game (except rabbit) is prohibited; provided, deer, moose, caribou, and elk lawfully killed and imported into the State under warden's tag may be sold under license at any time. Dealers may sell under license unplucked bodies of pheasant, Scotch grouse, European black game, European or gray partridge, red-legged partridge, and Egyptian or migratory quail imported from without the United States, but such birds must be tagged; fee, 5 cents a tag. Hares or rabbits lawfully secured and imported from a State or country where their sale is not prohibited may be sold during the open season. Live quail under State permit and waterfowl under Federal and State permits may be sold for propagation.

Export: Export of quail and ruffed grouse taken in State and of all migratory game birds prohibited; provided, a nonresident under his license may take 10 birds into another State according similar privilege, if carried open to view and the commission or district deputy is notified; provided further, a resident may export all game (except quail, ruffed grouse, woodcock), but more than two days' bag limit of migratory birds may not be exported in any one calendar week. No game illegally taken may be exported.

Miscellaneous: Deer may be taken with a shotgun only. Unlawful to hunt or kill game with rifle or revolver during open season for deer.

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[35] *Massachusetts:* Governor may suspend open seasons during extreme drought.

[36] Commission may open season on pheasants.

[37] License required to fish in inland waters which have been stocked with fish by the commission since January 1, 1910.

MICHIGAN.

Open seasons: [38]	*Dates inclusive.*
Deer (male, with horns not less than 3 inches above the skull)	Nov. 10–Nov. 30.
Rabbit, hare (see exception)	Oct. 15–Dec. 31.
Exception: Snowshoe or jack rabbit	Oct. 15–Mar. 1.
Squirrel (fox)	Oct. 15–Oct. 31.
Ruffed grouse (partridge), woodcock	Oct. 15–Nov. 20.
Duck, goose, brant, Wilson snipe, coot, gallinule	Sept. 16–Dec. 31.
Black-bellied and golden plovers, yellowlegs	Sept. 16–Dec. 15.
Rail, other than coot and gallinule	Sept. 1–Nov. 30.

No open season: Elk, moose, caribou, European partridge, dove, squirrel (except fox squirrel), quail, introduced pheasants, black game, capercailzie, hazel grouse, Canada or spruce grouse, prairie chickens, wild turkey (1924); swans, wood duck, eider ducks, auks, bitterns, sandhill and whooping cranes, gannet, grebes, gulls, herons, jaegers, loons, murres, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting licenses: [39] Nonresident: Deer, $50; small game, $10. Resident: Deer, $2.50; small game, $1. Issued by county clerks, commissioner, or deputy. Licenses issued to persons under 17 and over 12 on application of parent or guardian, who must accompany such minor when hunting. No license required of residents or minor children hunting small game on own inclosed land on which they reside.

Bag limits and possession: One deer a season; 5 fox squirrels a day, 10 in possession, 15 a season; 7 rabbits a day, 10 in possession, 25 a season; 5 partridge a day, 10 in possession, 25 a season; 25 ducks a day, 50 in possession, 50 a calendar week; 6 geese and brant a day or in possession, 25 a season; 6 woodcock a day, 20 in possession, 25 a season; 15 Wilson snipe a day, 25 a season; 15 in all of black-bellied and golden plovers and yellowlegs a day, 25 a season; 50 sora and 25 in all of other rails, coots, and gallinules a day. Possession of migratory birds permitted during first 10 days of close season, and other game during first 30 days thereof. Camping party of six or not less than four licensed hunters maintaining a camp of not less than four persons for not less than seven days may, under permit (fee $3), kill one deer for camp purposes.

Sale: Sale prohibited of all protected game, except rabbit; provided, deer skins and green or mounted buck-deer heads lawfully taken may be sold or transported under permit. Dealers may sell under license unplucked carcasses of pheasants of all species, Scotch grouse, European black game, red-legged partridge, Egyptian quail, European red deer, fallow deer, roe buck, and reindeer lawfully imported from another State or country, if properly tagged on arrival in State. Licensed retail dealer, club, hotel, restaurant, etc., may sell portion of said imported and tagged game to patron or customer for actual consumption or use.

Export: Export prohibited of all protected game.

Exceptions: (1) Deer may be transported outside the State to reach a point within the State.

(2) Nonresident licensee may take out, as hand baggage, open to view, 1 day's bag limit of birds, and may ship one deer lawfully killed by himself when license tag and seal are attached.

(3) Deer skins and green or mounted buck-deer heads may be exported under permit.

MINNESOTA.

Open seasons: [40]	*Dates inclusive.*
Deer, bull moose	Nov. 10–Nov. 20.
Black bear, rabbit (see exception)	Unprotected.
Exception: Varying hare, or snowshoe rabbit	Oct. 15–Mar. 1.

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[38] *Michigan:* The director upon approval of the Conservation Commission may shorten or close the season and otherwise restrict the taking of any species of game (except that he may not modify open seasons on waterfowl as fixed by Federal or State law) for a period not to exceed 5 years, in any county upon petition of 25 or more citizens of such county, if, upon public hearing, it is determined that the species is threatened with depletion or extinction. Such orders may be modified or rescinded when conditions warrant.

[39] Fishing licenses: Nonresident (over 21), general, $3; special, $1 (fish, except brook trout).

[40] *Minnesota:* All hunting prohibited within 3 miles of the corporate limits of Duluth, Minneapolis, and St. Paul.

Open seasons—Continued.	*Dates inclusive.*
Squirrel (gray, black, or fox)	Oct. 15–Mar. 1.[41]
Quail	Oct. 15–Nov. 30.
Ruffed grouse or partridge, ringneck pheasant (1921, 1922)	No open season.
Prairie chicken or pinnated grouse, white-breasted or sharp-tailed grouse (1921, 1922)	Sept. 16–Oct. 1.
Dove	Sept. 16–Oct. 1.
Woodcock	Oct. 1–Nov. 30.
Duck, goose, brant, coot, gallinule, Wilson snipe or jacksnipe, yellowlegs	Sept. 16–Dec. 31.
Rail, other than coot and gallinule	Sept. 16–Nov. 30.

No open season: Elk, cow moose, caribou, upland plover, imported pheasant (1922); black-bellied and golden plovers, swans, wood duck, eider ducks, auks, bitterns, little brown, sandhill, and whooping cranes, grebes, gulls, herons, jaegers, loons, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, and yellowlegs).

Hunting and fishing licenses: Nonresident or alien: Animals, $50; birds, $15. Issued by commissioner. Fishing license, $2 (not required of person under 16 years of age). Issued by commissioner, county auditors, game wardens, and agents. Resident: Big game animals, $2; birds, $1; fish house, $1. Issued by county auditor. Not issued to person under 14 years of age. Owners, lessees, or members of their immediate families may hunt birds without license during open season on own or leased land occupied by them as permanent residence. Unlawful to enter growing grain fields for purpose of hunting without permission of owner.

Bag limits and possession: One deer or 1 antlered moose (but not both) a season; 5 geese a day or in possession; 15 in all of ducks, coots, gallinules, Wilson snipe or jacksnipe, yellowlegs, and rails a day, 45 in possession; 10 quail, 5 ruffed grouse a day, 20 in possession, 30 a season, 9 in all of doves, prairie chickens, sharp-tailed grouse, and woodcock, but not more than 6 woodcock, a day; 18 prairie chickens and sharp-tailed grouse and 18 doves and woodcock a season. Possession permitted during first 5 days of close season. Under permit or tags deer and moose may be possessed to February 28, migratory birds for 10 days after close of season, and other game birds to January 31. Game (except migratory birds during first 10 days of close season) lawfully taken and possessed in another State may be imported and possessed at any time under proper retaining tags.

Sale: Sale of all protected game prohibited; provided, hides of deer and moose legally killed may be sold.

Export: Export of all protected game prohibited, except nonresident licensee may ship home in open season under his license coupons 1 deer, or 1 bull moose, and 25 birds lawfully taken by himself, but not more than 2 days' limit of migratory birds may be exported in any one calendar week. Deer and moose hides for tanning and heads for mounting may be exported when tagged with license coupons.

Miscellaneous: Unlawful to carry gun in motor vehicle unless taken apart or contained in a case. Unlawful to keep game in cold storage.

MISSISSIPPI.[42]

Open seasons:[42]	*Dates inclusive.*
Deer (male), bear	Nov. 15–Mar. 1.
Rabbit, squirrel	Unprotected.
Quail or partridge	Nov. 1–Mar. 1.
Wild turkey gobblers	Jan. 1–May 1.
Dove	Oct. 16–Jan. 31.
Waterfowl, Wilson snipe or jacksnipe, coot, poule d'eau, gallinule, black-bellied and golden plovers, yellowlegs	Nov. 1–Jan. 31.
Woodcock	Nov. 1–Dec. 31.
Rail, other than coot and gallinule	Sept. 1–Nov. 30.

No open season: Does; turkey hens, swans, wood duck, bitterns, sandhill crane, grebes, gulls, herons, loons, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting licenses: Nonresident, $20 (county license). Issued by sheriff. Landowners and their nonresident relatives and friends may hunt without license during open season on own lands.

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[41] *Minnesota:* Squirrels protected within corporate limits of any city or village, or within one-fourth mile thereof.

[42] *Mississippi:* Local regulations of boards of supervisors may also be in force, but those relating to migratory birds must not be inconsistent with Federal regulations.

Bag limits and possession: One deer a day, 5 a season; 20 ducks, 8 geese, 8 brant, 15 in all of plovers and yellowlegs, 25 Wilson snipe, 6 woodcock, 20 doves, 15 in all of rails, coots, and gallinules, but a mixed bag shall not exceed 20 birds. Possession of migratory birds permitted during first 10 days of close season.

Sale: Sale of all protected game prohibited.

Export: Export of all protected game prohibited.

MISSOURI.

Open seasons:	*Dates inclusive.*
Deer (buck), wild turkey	Dec. 1–Dec. 31.
Squirrel	June 1–Dec. 31.
Quail (bob-white partridge)	Nov. 10–Dec. 31.[43]
Duck, goose, brant, Wilson snipe, coot, gallinule, black-bellied and golden plovers, yellowlegs	Sept. 16–Dec. 31.
Woodcock	Nov. 10–Nov. 30.
Rail, other than coot and gallinule	Sept. 15–Nov. 30.

No open season: Does, fawns under 1 year of age, ruffed grouse (pheasant), prairie chicken (pinnated grouse), imported pheasants, other introduced game birds, dove; swans, wood duck, bitterns, little brown, sandhill, and whooping cranes, grebes, gulls, herons, jaegers, loons, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses: Nonresident or alien, $10; fish only, $3. Issued by commissioner. Resident, State, $2.50; county, $1, good in county of residence or adjoining county; fish only (State), $1. Issued by county clerk or license collector. Fishing license not required in county of residence nor of women and minors who are citizens. Owners and tenants of agricultural lands and members of family under 21 may hunt without license during open season on own or leased land. Hunting on land of another prohibited without his consent.

Bag limits and possession: One deer, 4 turkeys a season; 1 turkey, 10 quail, 15 ducks, 8 geese, 8 brant, 15 in all of plovers and yellowlegs, 15 Wilson snipe a day; 15 rails, 15 coots, 15 gallinules, but not more than 25 in all a day or in possession; or 2 turkeys, 15 quail, 25 of any other species of birds in possession. Possession of migratory birds, except doves, permitted during first 10 days of close season; other game during first 5 days thereof.

Sale: Sale of all protected game prohibited.

Export: Export of all protected game prohibited, except game may be exported under resident or nonresident license if carried openly as baggage or express or in owner's possession and accompanied by him, but more than 2 days' limit of migratory birds may not be exported in any one calendar week. Export (except of quail) for scientific or propagating purposes allowed under permit.

MONTANA.

Open seasons:[44]	*Dates inclusive.*
Deer (male with visible horns) (see exception)	Nov. 1–Dec. 1.
Exception: Deer in Carter, Custer, Dawson, Gallatin, Garfield, McCone, Phillips, Powder River, Richland, Roosevelt, Rosebud, Stillwater, Teton, Valley, Yellowstone, and part of Fergus County (1924).	
Elk in Flathead, Glacier, Madison, Park, Pondera, Sweet Grass, Teton, and parts of Gallatin, Lewis and Clark (except north North Fork Dearborn River, Nov. 6–15), Missoula, and Powell Counties	Oct. 15–Nov. 15.
Pheasant, partridge, prairie chicken, fool hen, grouse in Flathead, Lincoln, Missoula, and Sanders Counties only	Oct. 1–Oct. 15.
Duck, goose, brant, black-bellied and golden plovers, Wilson snipe or jacksnipe, yellowlegs, coot, gallinule	Sept. 16–Dec. 31.
Rail, other than coot and gallinule	Sept. 1–Nov. 30.

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[43] *Missouri:* Upon petition of 100 householders to the county court, at any regular or special term thereof, more than 30 days before a general election to be held in such county, the question of a close season on quail for the next two years in such county may be submitted to the qualified voters therein at the election.

[44] *Montana:* Commission may close season in any district on any species of game threatened with undue depletion from any cause.

No open season: Sheep, goat (1926); elk (except as above), does and fawns, moose, caribou, antelope, bison or buffalo; pheasant, partridge, grouse, prairie chicken, fool hen (except as above) (1923); quail, sage hen, introduced pheasant, dove, swans, wood duck, bittern, little brown, sandhill, and whooping cranes, grebes, gulls, herons, loons, band-tailed pigeon, terns, and all shorebirds (except Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses: Nonresident: General, $30; birds and fish, $10; fish, $3.50. Alien: General, $50; fish, $10. Resident: General, $2.00. Guide (resident), $10. Shipping (export), 50 cents. Issued by warden or deputy.

No license required of minor under 15. Alien not holding a hunting license required to obtain from warden $25 license to possess firearms.

Bag limits and possession: One deer, 1 elk a season; 5 each of grouse, partridges, prairie chickens, fool hens, pheasants, and sage hens a day or in possession; 20 ducks, 8 geese, 8 brant, 15 in all of plovers and yellowlegs, 25 Wilson snipe, 50 sora, 25 in all of other rails, coot, and gallinules a day. Possession of migratory birds except waterfowl permitted during first 10 days of close season.

Sale: Sale of all protected game prohibited; provided, merchant or hotel or restaurant keeper may sell game, except migratory birds, killed outside the State. Under permit mounted specimens or hides or heads of game animals or birds lawfully taken may be sold.

Export: Export of all protected game prohibited; provided, game lawfully killed may be exported in open season under hunting license, and shipping permit (fee, 50 cents) from State warden; total shipments under one license may not exceed season's bag limit, and not more than 2 days' limit of migratory birds may be exported in any one calendar week; packages to be labeled to show contents.

NEBRASKA.

Open seasons:	*Dates inclusive.*
Squirrel (gray, red, fox, timber)	Sept. 16–Dec. 31.
Prairie chicken, grouse	Oct. 1–Nov. 1.
Duck, goose, brant, Wilson snipe or jacksnipe, black-bellied and golden plovers, yellowlegs, coot, gallinule	Sept. 16–Dec. 31.
Rails, other than coot and gallinule	Sept. 16–Nov. 30.

No open season: Deer, elk, antelope, mountain sheep, quail, partridge, sage hen, pheasant, ptarmigan, introduced game birds, dove, wild turkey, woodcock, swans, wood duck, bitterns, little brown, sandhill, and whooping cranes, grebes, gulls, herons, jaegers, loons, terns, and all shorebirds (except Wilson snipe or jacksnipe and yellowlegs).

Hunting and fishing licenses: Nonresident: General, $10.10; fish, $2.10. Alien: General, $15.10; fish, $5.10. Resident, $1.10. Issued by State department of agriculture and authorized vendors. Licenses required of all persons over 16 years of age.

Bag limits and possession: Ten squirrels a day, 20 in possession; 10 prairie chicken or grouse a day or in possession; 25 ducks a day, 50 in possession; 8 geese, 8 brant a day, 10 each in possession; 15 Wilson snipe a day, 25 in possession; 15 in all of plovers and yellowlegs a day, 25 in possession; 15 rails, 25 coots, but not more than 25 rails and coots a day, 25 rails and 50 coots in possession, 50 in all of game birds in possession. Possession permitted during first 10 days of close season.

Sale: Sale of all protected game prohibited.

Export: Game may be transported by express or baggage during the open season if shipment is accompanied by shipper's affidavit that the game is not for sale or profit and was not taken contrary to law; package must be labeled with consignor's license number and number and kind of game, consigned to shipper, and accompanied by him; shipment must not contain more than 50 game birds or the possession bag limit on any species. Not more than two days' limit of migratory birds may be exported in any one calendar week.

NEVADA.

Open seasons:[45]	*Dates inclusive.*
Deer (male with horns), antelope (with horns)	Oct. 14–Nov. 12.[45]
Prairie chicken	Oct. 1–Jan. 15.
Sage hen	Aug. 1–Aug. 31.
Dove	Sept. 1–Dec. 15.
Duck, goose, brant, coot, gallinule, Wilson snipe or jacksnipe, black-bellied and golden plovers, yellowlegs	Sept. 16–Dec. 31.
Rails, other than coot and gallinule	Sept. 1–Nov. 30.

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[45] *Nevada:* County commissioners may shorten open seasons on game upon petition of 50 or more resident electors of county; and may designate open season of one month on buck deer or buck antelope between September 15 and December 15, instead of October 14 to November 12, or close season entirely.

No open season: Elk, sheep, goat (1930); mountain quail, grouse (1922); pheasant; swans, wood duck, bitterns, little brown and sandhill cranes, grebes, gulls, herons, loons, murres, band-tailed pigeon, terns, and all shore birds (except Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses:[46] Nonresident: Game, $10; fish, $3. Alien: Fish, $7.50. Resident citizen: Game, $1.50; fish, $1.50. Issued by county clerks and wardens. Aliens prohibited from hunting. No license required of boys or girls under 14. Landowners may hunt and fish on own land without license during open season.

Bag limits and possession: One deer and 1 antelope a season; 10 sage hens, 25 ducks, 8 geese, 8 brant, 25 snipe, 15 in all of plovers and yellowlegs, 50 sora, and 25 in all of other rails, coots, and gallinules, and 25 doves a day. Possession of migratory birds permitted during first 10 days of close season.

Sale: Sale of all protected game prohibited.

Export: Export of all protected game prohibited.

NEW HAMPSHIRE.

Open seasons:[48]	*Dates inclusive.*
Deer in Coos County	Oct. 15–Nov. 30.
In Carroll County	Nov. 15–Dec. 15
In Grafton County	Nov. 1–Dec. 15.
In rest of State	Dec. 1–Dec. 31.
Hare, rabbit	Oct. 1–Feb. 28.
Partridge, ruffed grouse, woodcock	Oct. 1–Nov. 30.
Duck, goose, brant, Wilson snipe or jacksnipe, coot, gallinule	Sept. 16–Dec. 31.
Black-bellied and golden plovers, yellowlegs	Aug. 16–Nov. 30.
Rails, other than coot and gallinule	Sept. 1–Nov. 30.

No open season: Elk, moose, caribou, dove, quail, pheasant, European partridge; gray squirrel (1924); swans, wood duck, eider ducks, auks, bitterns, sandhill crane, gannet, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses: Nonresident: Game and fish, $15; fish, $2.15. Resident: Game and fish, $1. Resident soldiers and sailors over 70 years of age may hunt and fish without a license. Fishing licenses not required of children under 16 years of age, nor of women or blind people. Issued by commissioner or his agent in each town, who with few exceptions is the town clerk. Licenses not granted to children under 13 years of age, and only with written consent of parent or guardian to minors under 16 years. Child under 13 may hunt without license when accompanied by licensed parent or guardian. Resident owner of farm lands and minor children may hunt during open season on own land without license. Guide: Nonresident, $20; resident, $1. Issued by commissioner.

Bag limits and possession: Two deer a season in Coos and Carroll Counties, 1 in rest of State (person securing 1 deer in any of the one-deer counties may take 1 additional deer in Coos or Carroll County); 5 hares a day; 5 ruffed grouse a day, 25 a season; 5 woodcock a day, 25 a season; 20 ducks, 8 geese, 8 brant, 25 Wilson snipe, 15 in all of plovers and yellowlegs, 50 sora, and 25 in all of other rails, coots, and gallinules a day. Deer may be possessed for a reasonable time after close of open season.

Sale: Sale of all migratory birds prohibited. Sale for food purposes prohibited of the dead bodies of birds belonging to a family any species or subspecies of which is native to and protected by the State; provided, deer, hares, and rabbits may be sold during the open season.

Export: Export of all protected game prohibited; provided, game (except ruffed grouse) imported from without the United States or raised in private preserves, when tagged and marked to show kind and number, name and address of consignor and consignee, and initial point of billing and destination, may be exported unaccompanied by the owner, but not more than two days' limit of migratory birds may be exported in any one calendar week. Game for propagation, the head, hide, feet, or fur of game quadrupeds, and the plumage or skin of game birds (except migratory birds) legally taken and possessed may be transported without being marked.[49] Nonresident may take out of the State, under his hunting license and permit, one day's limit of game birds when properly marked and tagged and two deer under license tags.

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[46] *Nevada:* Citizen of any State must pay same fee for hunting or fishing license as charged nonresidents by his State of residence.

[48] *New Hampshire:* Governor and council may suspend open season in time of excessive drought.

[49] See sec. 243, Lacey Act, p. 58.

NEW JERSEY.

Open seasons:	*Dates inclusive.*
Deer[50] (male, with horns visible above the hair)	Dec. 16–Dec. 20.
Raccoon	Oct. 1–Dec. 15.
Rabbit, squirrel, quail, ruffed grouse (partridge), prairie chicken, Hungarian partridge, English or ringneck pheasant cocks (see exception)	Nov. 10–Dec. 15.
Exception: Ringneck pheasant in and within 1 mile of Cinnaminson, Chester, and Delran Townships, in Burlington County, and Pennsauken Township, in Camden County	No open season.
Duck, goose, brant, Wilson snipe or jacksnipe, coot, gallinule	Oct. 16–Jan. 31.
Black-bellied and golden plovers, yellowlegs	Aug. 16–Nov. 30.
Woodcock	Oct. 1–Nov. 30.
Rail (marsh hen), other than coot and gallinule	Sept. 1–Nov. 30.

No open season: Does and fawns, wild turkeys, English or ringneck pheasant hens, doves, reedbirds, swans, wood ducks, elder ducks, auks, bitterns, little brown, sandhill, and whooping cranes, fulmars, gannet, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses: Nonresident: Game and fish (1921), $10.15; (1922), $10.50; fish (1921), $2.15; (1922), $3.25. Resident male citizen above age of 14: Game and fish (1921), $1.15; (1922), $1.65. When applied for by parent or legal guardian, in discretion of commission, license may be granted to citizen between ages 10 and 14 to hunt when accompanied by adult holder of a general license; fee, $1; issued only by commission. All other licenses issued by county, city, or town clerk, salaried warden, or registrar of licenses.

Alien prohibited from hunting or owning shotgun or rifle unless he is the owner of real property in New Jersey to the value of $2,000 above all incumbrances, in which case he may secure nonresident license.

Bag limits and possession: One deer a season; 10 rabbits, 10 quail, 3 ruffed grouse, 3 English or ringneck pheasant cocks, 3 Hungarian partridges, 6 woodcock, 25 ducks, 8 geese, 8 brant, 25 snipe, 15 in all of plovers and yellowlegs, 50 reedbirds, 50 sora, and 25 in all of other rails (marsh hens), coot, and gallinules, a day or in possession. Possession of all game (except deer) permitted during the first 10 days of close season.

Sale: The sale of deer, squirrel, reedbirds, and all game birds is prohibited; rabbits may be sold during open season and 10 days thereafter; Belgian hares and jack rabbits legally killed in another State may be imported and sold at any time; the unplucked carcasses of Canada geese and mallard, wood, and black ducks (when raised in captivity under Federal and State permits), deer, squirrel, quail, ruffed grouse, and pheasants raised on licensed game preserves and properly tagged, and the unplucked carcasses of Scotch grouse, European black grouse, European black plover, red-legged partridge, and Egyptian quail coming from a foreign country, which are properly tagged by State authorities, may be sold at any time for food purposes.

Export: Export of all protected game (except deer) prohibited, except a nonresident licensee, in one day, may carry from State the daily bag limit of game, if open to view, but not more than two days' limit of game may be exported in one calendar week.

Miscellaneous: Unlawful to use shotgun or rifle holding more than 2 cartridges or that may be fired more than twice without reloading.

NEW MEXICO.

Open seasons:[51]	*Dates inclusive.*
Deer (with horns at least 6 inches in length), squirrel (tassel-eared gray), wild turkey	Nov. 20–Nov. 30.
Quail (except bobwhite)	Nov. 1–Dec. 31.
Turtle dove and white-winged dove, black-bellied and golden plovers, yellowlegs	Sept. 1–Dec. 15.
Duck, goose, brant, Wilson snipe, coot, gallinule	Oct. 16–Jan. 31.
Rails, other than coot and gallinule	Sept. 1–Nov. 30.

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[50] *New Jersey:* Wild deer may be taken only with shotgun not smaller than 12 gauge, which may not be loaded with a bullet or other missile larger than buckshot. Killing of a deer must be reported to commissioners or county warden within 48 hours. Landowner or his authorized agent may kill deer on his own cultivated land at any time; carcass of deer so killed is the property of the commission, and such killing must be reported within 48 hours.

[51] *New Mexico:* Commission may close season in any locality on any species, and may prohibit all hunting, in periods of extreme forest fire danger, at such times and places as may be necessary.

No open season: Does, Sonoran deer, elk, sheep, goat, antelope, buffalo, bobwhite quail, pheasant, ptarmigan, prairie chicken, sage hen, grouse, swans, wood duck, bitterns, little brown, sandhill, and whooping cranes, grebes, gulls, herons, loons, band-tailed pigeons, terns, and all shorebirds (except Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses: Nonresident: Big game, bird, and fish, $35.25; big game and bird, $30.25; big game, $25.25; bird, $10.25; fish, $5. Resident: Big game, bird and fish, $2.50; big game and bird, $2.25; big game, $1.50; bird, $1.25; fish, $1; guide, $5.25; duplicate, $1. Issued by county clerks and deputies designated by State warden. Alien resident of New Mexico or an adjoining State not permitted to hunt or to own or possess shot gun or rifle in State.

Bag limits and possession: One deer a season; 3 wild turkeys, 20 quail, 25 doves a day or in possession; 25 ducks, 8 geese, 8 brant, 25 Wilson snipe, 15 in all of plovers and yellowlegs, 50 sora and 25 in all of other rails, coots, and gallinules a day. Possession permitted during open season and first 5 days of close season. Under permit, game, except migratory birds, may be held in storage for first 90 days of close season; migratory birds may be so held for a period of 10 days.

Sale: Sale of all protected game taken in the State prohibited; provided, game (except migratory birds) imported into State by hotel, restaurant, café, boarding-house keeper, or dealer may be sold under a permit good for not more than 30 days.

Export: Export of all game taken in the State prohibited, except under permit, fee $1.25 1 deer and 3 turkeys; and $1.25 for bag limit of other birds and fish; holder of hunting license, under permit from warden, may export game or birds for scientific or propagating purposes.

NEW YORK.

Open seasons:[52]	*Dates inclusive.*
Deer (with horns not less than 3 inches long) in Adirondack region[53]	Oct. 15–Nov. 15.
Deer (with horns not less than 3 inches long), in Columbia, Delaware, Greene, Orange, Rensselaer,[54] Sullivan, and Ulster Counties	Nov. 1–Nov. 15.
On own land in Dutchess County[54]	Nov. 1–Nov. 15.
Varying hare, rabbit[52]	Oct. 1–Mar. 1.
Squirrel, black, gray, or fox	Oct. 15–Nov. 15.[55]
Grouse, partridge[52]	Oct. 15–Nov. 15.
Pheasant, male only[52] (four days only)	Oct. 20 and 27. Nov. 5 and 12.
Waterfowl, Wilson snipe or jacksnipe, coot, gallinule	Sept. 16–Dec. 31.
Black-bellied and golden plovers, yellowlegs	Aug. 16–Nov. 30.
Woodcock	Oct. 1–Nov. 15.
Rails, other than coot and gallinule	Sept. 1–Nov. 30.

No open season: Elk, moose, caribou, antelope, fawns; Hungarian or European gray-legged partridge; dove; quail (1925); swans, wood duck, eider ducks, auks, bitterns, sandhill and whooping cranes, fulmars, gannet, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting licenses:[56] Nonresident or alien, $10.50; resident, $1.10. Issued by county, city, and town clerks. Owners, members of immediate families, and tenants actually occupying cultivated farm land may hunt thereon without license during open season. Licensee required to wear button.

Bag limits: One deer, 24 woodcock, 10 grouse, 3 male introduced pheasants a season; 6 varying hares or rabbits, 5 squirrels, 6 woodcock, 2 grouse, 25 ducks, 8 geese, 8 brant, 25 in all of rails, coots, mud hens and gallinules, 15 in all of plovers and yellowlegs, 25 Wilson snipe or jacksnipe a day.

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[52] *New York:* Commission may shorten open seasons on game. Open season on upland game fixed or closed by order of commission as follows: *Cottontail rabbit* in Richmond County, October 1–November 14 and January 1–31.

[53] The Adirondack region comprises the counties of Clinton, Essex, Franklin, Fulton, Hamilton, Herkimer, Jefferson, Lewis, Oneida, Oswego, Saratoga, St. Lawrence, Warren, and Washington.

[54] In Dutchess and Rensselaer Counties, deer may only be taken with shotgun loaded with slugs or shot not smaller than buckshot.

[55] May only be taken in corporate limits of city or village under permit of commission.

[56] Nonresident fishing license fee, $2.50. Issued by county, city, and town clerks. Not required of persons under 16 years of age or in international boundary waters if residents require no license in that part of those waters not within jurisdiction of State.

Possession: Deer, grouse, and pheasant during open season and 5 days thereafter; migratory game birds during open season and 10 days thereafter. Deer properly tagged may be possessed under $1 permit to February 1.

Sale: Sale of all game birds prohibited; provided, varying hares and rabbits legally taken in State during open season (from without State at any time), and unplucked carcasses of pheasants, Scotch grouse, European gray-legged partridge, European black game, red-legged partridge, and Egyptian quail, and carcasses of European red deer, fallow deer, roebuck, and reindeer imported from without the United States may be sold under license at any time when duly tagged.

Licensed breeders in States having laws similar to the game-breeding law of New York may import, under $5 license and cost of inspection, domesticated American elk, white-tailed deer, European red deer, fallow deer, roebuck, pheasants, Canada and Hutchins geese, and mallard and black ducks, when duly tagged, for sale under regulations of conservation commission.

Head, hide, and feet of quadrupeds legally taken and possessed may be sold at any time.

Export: Export of game and birds prohibited, except any person may export 1 deer and one day's bag limit of other game in one day during open season by means other than parcel post. The taker may export in one day by common carrier, except parcel post, one day's limit when accompanied by permit which shall show contents of package. Head, hide, and feet of animals and plumage or skin of game birds legally taken may be exported at any time.

Miscellaneous: Hunting prohibited on lands supplying any municipality with water or on public highways, except public highways within forest preserve counties.

NEW YORK—Long Island.

Open seasons:	*Dates inclusive.*
Squirrel (black, gray, fox), quail, ruffed grouse, pheasant (male only)	Nov. 1–Dec. 31.
Varying hare	Oct. 1–Mar. 1.
Cottontail rabbit	Nov. 1–Dec. 31.
Waterfowl, Wilson snipe or jacksnipe, coot, mudhen, gallinule	Oct. 16–Jan. 31.
Black-bellied and golden plovers, yellowlegs	Aug. 16–Nov. 30.
Woodcock	Oct. 1–Nov. 15.
Rail, other than coot and gallinule	Sept. 1–Nov. 30.

No open season: Deer, dove, swans, wood duck, eider ducks, auks, bitterns, sandhill and whooping cranes, fulmars, gannet, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Bag limits and possession: Forty quail, 10 ruffed grouse, 30 male pheasants a season; 6 quail, 2 ruffed grouse, 4 male pheasants a day. For other bag limits see New York.

Hunting licenses, sale, export, miscellaneous: (See New York.)

NORTH DAKOTA.

Open seasons:	*Dates inclusive.*
Deer (male, with horns)	Nov. 21–Nov. 30.[57]
Prairie chicken (pinnated grouse), sharp-tailed (white-breasted) grouse, black-bellied and golden plovers, yellowlegs, Wilson snipe	Sept. 16–Oct. 16.
Ruffed grouse in Bottineau, Cavalier, Pembina, and Roulette Counties only	Oct. 1–Oct. 10.
Duck, goose brant	Sept. 16–Dec. 1.
Coot, gallinule	Sept. 16–Dec. 31.
Woodcock	Oct. 1–Oct. 16.
Rail, other than coot and gallinule	Sept. 1–Nov. 30.

No open season: Does and fawns; elk, moose, antelope, quail, ruffed grouse (except as above), English and Chinese ringneck pheasants, Hungarian partridge, dove, swans, wood duck, bitterns, little brown, sandhill, and whooping cranes, grebes, gulls, herons, loons, shearwaters, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting licenses: Nonresident, $25; resident, $1.50. Issued by commissioners, deputy, or county auditor. Aliens not permitted to hunt. Person or member of family permanently residing with him may hunt without license during open season on own lands or lands cultivated by him. Resident license may be issued to settler. No person permitted to enter cultivated or posted lands without consent of owner.

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[57] *North Dakota:* Deer hunter must wear coat and hat of dark blue or black material.

Bag limits and possession: One deer a season; 5 prairie chickens, sharp-tailed grouse, plovers, each or all combined a day, 10 each or all in possession at one time, 15 in all of plovers and yellowlegs, but not more than 5 plovers a day; 5 ruffed grouse a day, 15 in possession; 15 snipe, woodcock, ducks, geese, each or all combined a day, but not more than 8 geese, 8 brant, or 6 woodcock, 30 in possession; 25 in all of rails, coots, and gallinules a day. Resident licensee under permit may retain not to exceed 20 pinnated or sharp-tailed grouse, 30 waterfowl, but not more than 50 birds in all during first 5 days of close season.

Sale: Sale of all protected game prohibited, except hides, heads, and trophies of big game lawfully taken may be sold at any time.

Export: Export of all protected game prohibited, except nonresident licensee may carry with him from State under license tag prairie chickens and sharp-tailed grouse not exceeding 20 in all, and ducks, geese, and brant not exceeding 30 in all, or a total of 50 of all birds combined, if open to view and labeled with his name and address and number of his license. Not more than 2 days' limit of migratory birds shall be exported in any one calendar week. Board may grant permits for the export of live game.

NORTH CAROLINA.[58]

Open seasons:[58]	*Dates inclusive.*
Dove	Oct. 16–Jan. 31.
Duck, goose, brant, Wilson snipe or jacksnipe, coot, gallinule	Nov. 1–Jan. 31.
Black-bellied and golden plovers, yellowlegs	Sept. 1–Dec. 15.
Woodcock	Nov. 1–Dec. 31.
Rail, other than coot and gallinule	Sept. 1–Nov. 30.
Reedbird (ricebird)	Aug. 16–Nov. 15.[58]

No open season: Swans, wood duck, auks, bitterns, gannet, grebes, gulls, herons, jaegers, loons, murres, petrels, shearwaters, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting licenses: [58]

Bag limits and possession: Twenty-five doves, 25 ducks, 8 geese, 8 brant, 6 woodcock, 25 Wilson snipe, 15 in all of plovers and yellowlegs, 50 sora and 25 in all of other rails, coots, and gallinules a day. Possession of migratory birds permitted during first 10 days of close season.

Sale: Sale of reedbirds (ricebirds) and all migratory birds prohibited.

Export: The export is prohibited of quail, partridge, pheasant, grouse, wild turkey, snipe, shore or beach birds, woodcock, taken in State.

Exceptions: Nonresident may take out of State under his hunting license 50 quail (partridges), 12 grouse, 2 turkeys, and 50 in all of Wilson snipe, plovers, and yellowlegs in a season, but not more than two days' limit of migratory birds shall be exported in any one calendar week. Export permitted under permit of Audubon Society of ruffed grouse and wild turkey for propagation.

OHIO.

Open seasons:	*Dates inclusive.*
Hare, rabbit	Nov. 15–Jan. 1.[59]
Squirrel	Sept. 15–Oct. 20.
Ruffed grouse, cock pheasant (introduced), Hungarian partridge	Nov. 15–Nov. 25.
Duck, goose, brant, Wilson snipe, black-bellied and golden plovers, yellowlegs, coot, gallinule	Sept. 16–Dec. 31.
Woodcock	Oct. 1–Nov. 30.
Rail, other than coot and gallinule	Nov. 1–Nov. 30.

No open season: Deer, quail, dove, swans, wood duck, eider ducks, bitterns, sandhill and whooping cranes, grebes, gulls, herons, jaegers, loons, murres, petrels, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

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[58] *North Carolina:* Only the Federal seasons and other restrictions on migratory birds are given. County seasons and provisions relating to licenses, bag limits, sale, and export are too numerous to be included. Full information regarding laws applicable to counties under jurisdiction of Audubon Society may be had on application to the secretary, Audubon Society, Raleigh, N. C. The county laws should be consulted, as in some instances they prohibit the hunting of migratory game birds during part of the periods mentioned in the table. Wood duck, swans, robins, larks, and certain other migratory birds may not be killed at any time. (See Migratory Bird Regulations, pp. 67–72; and order of the Secretary of Agriculture, regarding reedbirds, p. 73.)

[59] *Ohio:* Landowners, tenants, and employees may take hares or rabbits, when doing substantial damage to crops, trees, or shrubbery, at any time except on Sunday.

Hunting and fishing licenses: Nonresident citizen: General, $15.25; fish, $2. Resident citizen, $1.25. Issued by county and township clerks. Person under 16 when hunting must be accompanied by adult. Owners, tenants, or their children may hunt without license during open season on own or leased lands. Written permission required on land of another.

Bag limits and possession: Five squirrels and 10 rabbits a day or in possession; 3 ruffed grouse, 3 cock pheasants, and 6 Hungarian partridge, 15 in all of plovers and yellowlegs, 15 Wilson snipe, 6 woodcock, 8 geese, 25 ducks; 35 sora and 25 in all of other rails, coots, and gallinules a day. Waterfowl, coots, and gallinules may be possessed during first 10 days of close season.

Sale: Sale prohibited of all protected game (except hare or rabbit during open season).

Export: Export prohibited of all protected game (except rabbit) taken in State; provided, a nonresident may take with him from State under his hunting license 25 pieces of game. But not more than two days' limit of migratory birds may be exported by one person in any one calendar week. Packages containing game or fur-bearing animals or parts thereof must be marked to show contents, initial point of billing, and names and addresses of consignor and consignee.

OKLAHOMA.

Open seasons:	*Dates inclusive.*
Bear.[60]	
Quail	Dec. 1–Dec. 31.
Duck, goose, brant, Wilson snipe or jacksnipe, coot, gallinule	Oct. 16–Jan. 31.
Black-bellied and golden plovers, yellowlegs, dove	Sept. 1–Dec. 15.
Woodcock	Nov. 1–Dec. 31.
Rail, other than coot and gallinule	Sept. 1–Nov. 30.

No open season: Deer (1922), antelope, prairie chicken, imported pheasant, wild turkey, swans, wood duck, bitterns, little brown, sandhill and whooping cranes, grebes, gulls, herons, loons, band-tailed pigeons, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting licenses: Nonresident, $15; alien, $25; resident citizen, $1.25. Issued by warden, deputy, or county clerk. A person may hunt without license during open season on own or leased premises actually occupied by him. Application of person under 14 must be approved in writing by parent or guardian. Unlawful to shoot on or across highway or railroad right of way. Unlawful to hunt on lands of another without owner's permission.

Bag limits and possession: Fifteen quail, plover, snipe, or ducks a day, 100 a season; 15 yellowlegs, but not more than 15 in all of plovers and yellowlegs a day; 8 geese, 8 brant a day, but not more than 10 in all a day; 50 sora and 25 in all of other rails, coots, and gallinules and 6 woodcock a day. Possession of migatory birds permitted during first 10 days of close season.

Sale: Sale prohibited of all protected game, except that heads, hides, and horns of big game lawfully killed may be sold.

Export: Export prohibited of all protected game, but nonresident licensee may carry to his home two days' bag limit of game birds if license permit is attached.

OREGON.[61]

Open seasons:	*Dates inclusive.*
District No. 1,[62] west of Cascades:	
Deer (male with horns)	Aug. 20–Oct. 20.
Silver-gray squirrel	Sept. 15–Oct. 15.
Quail (mountain, or plumed, and California valley) in Coos, Curry, Jackson, and Josephine Counties only	Oct. 1–Oct. 31.
Grouse, Chinese pheasant, bob-white quail (see exceptions)	Oct. 15–Oct. 31.
Exceptions: Blue or sooty grouse in Douglas, Jackson, and Josephine Counties	Sept. 1–Sept. 30.
Chinese pheasants in Coos, Curry, and Josephine Counties	No open season.
Duck, goose, brant, Wilson snipe, coot, black-bellied and golden plovers, yellowlegs	Oct. 1–Jan. 15.
Rail, other than coot	Oct. 1–Nov. 30.

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[60] *Oklahoma:* Bear in Blaine, Caddo, Comanche, Kiowa, and Major Counties, no open season; in rest of State, unprotected.

[61] *Oregon:* Commission may open or close the season on any species of game in any county or district for such time as it may designate.

[62] District No. 1, west of Cascades, includes Benton, Clackamas, Clatsop, Columbia, Coos, Curry, Douglas, Jackson, Josephine, Lane, Lincoln, Linn, Marion, Multnomah, Polk, Tillamook, Washington, and Yamhill Counties. District No. 2, east of Cascades, includes all other counties in the State.

Open seasons—Continued.	*Dates inclusive.*
District No. 2,[63] *east of Cascades:*	
Deer (male, with horns) (see exception)	Sept. 1–Oct. 31.
Exception: In Union and Wallowa Counties	Sept. 10–Nov. 10.
Quail (mountain, or plumed, and California valley) in Klamath County only	Oct. 1–Oct. 10.
Grouse (see exception)	Sept. 1–Oct. 31.
Exception: In Union and Wallowa Counties	Sept. 1–Nov. 10.
Prairie chicken in Sherman, Union, and Wasco Counties only	Oct. 1–Oct. 15.
Sage hen	Aug. 1–Aug. 31.
Chinese pheasants in Baker, Grant, Malheur, Umatilla, Union, and Wallowa Counties	Oct 2–Oct. 9.
In Hood River and Wasco Counties	Nov. 1–Nov. 10.
In remainder of district	No open season.
Duck, goose,[64] Wilson snipe or jacksnipe, black-bellied and golden plovers, yellowlegs, coot	Sept. 16–Dec. 31.
Rail, other than coot	Sept. 16–Nov. 30.

No open season: Doe and spotted fawn, moose, elk, antelope, sheep, goat, Hungarian partridge, bobwhite, prairie chicken, Franklin grouse, foolhen, wild turkey, silver-gray squirrel, quail, and introduced pheasants (except as above), dove; swans, wood duck, auklets, auks, bitterns, little brown and sandhill cranes, fulmars, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, band-tailed pigeon, puffins, shearwaters, terns, and all shorebirds (except Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses: Nonresident: Game, $10; alien, gun license, $25 (in addition to hunting and angling license). Resident, game and fish, $5; game, $3; hunting or angling, $1.50 (county license issued to residents between 14 and 18 years of age). Angling, resident or nonresident,[65] $3 (not required of female). Licenses issued by county clerks and duly appointed agents throughout the State. Guide, $3 (issued only to citizen of United States); issued by commission. Licenses not issued to persons under 14 years of age. Owner and member of his family may hunt, trap, or fish on own premises without license during open season. Licenses, good for life, issued free of charge by county clerks to pioneers of State who arrived prior to 1860, veterans of Indian and Civil Wars upon proof of service, and Spanish-American War veterans resident in State Soldiers' Home. Unlawful to hunt on inclosed or occupied land of another without permission of owner. Unlawful to shoot from highways or railroad rights of way.

Bag limits and possession: Two deer a season; 5 silver-gray squirrels and 10 quail in 7 consecutive days; 5 in all of sage hens and prairie chickens a day, 10 in 7 consecutive days; 5 in all of ruffed grouse, pheasants, and sooty or blue grouse a day, 10 in 7 consecutive days; 5 Chinese pheasants a day, 10 in 7 consecutive days, but in district 1 a bag of 10 shall not include more than 3 hens and in district 2 more than 2 hens; 25 ducks, 25 Wilson snipe, 15 in all of plovers and yellowlegs, 25 in all of rails, coots, and gallinules a day, but not more than 25 in all in one day nor more than 30 in all in 7 consecutive days; 8 geese a day, 30 in 7 consecutive days. Migratory game birds properly tagged may be possessed during first 10 days of close season; other game, when properly tagged, during close season.

Sale: Sale of all protected game prohibited. Game birds (except migratory birds) and animals imported from without the United States, when duly tagged, may be sold. Tag fee, 5 cents each. Commission may make regulations permitting the sale of game, except migratory birds.

Export: Export of all protected game prohibited, except when tagged with metal seal and accompanied by permit from State Warden showing kind of game and names and addresses of consignor and consignee.

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[63] District No. 2, east of Cascades, includes all counties not in District No. 1 (see footnote 62).

[64] Unlawful to kill geese at any time on islands or sand bars in the Columbia east of Hood River or on Deschutes and John Day Rivers south to junction with White River and Thirtymile Creek, respectively.

[65] Fee required of nonresident angler equal to that required of nonresident in his State of residence.

PENNSYLVANIA.

Open seasons:[66]	*Dates inclusive.*
Deer—male with horns 4 inches above the skull	Dec. 1–Dec. 15.[67]
Bear	Nov. 1–Dec. 15.[67]
Raccoon	Oct. 1–Jan. 31.
Hare, rabbit	Nov. 1–Dec. 15.
Squirrels (black, gray, fox), quail, ruffed grouse, ringneck pheasant, Hungarian partridge, wild turkey	Nov. 1–Nov. 30.
Red or pine squirrel	Nov. 1–Aug. 15.
Duck, goose, brant	Sept. 16–Dec. 31.
Black-bellied and golden plovers, yellowlegs, coot (mudhen), gallinule, Wilson snipe or jacksnipe	Sept. 16–Nov. 30.
Woodcock	Oct. 1–Nov. 30.
Rail	Sept. 1–Nov. 30.
Reedbird	Sept. 1–Oct. 30.[68]
Blackbird	Aug. 1–Nov. 30.

No open season: Elk (1923), doe, fawn, dove, swans, wood duck, eider ducks, auks, bitterns, little brown and sandhill cranes, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting licenses: Nonresident, $10. Issued by commission or county treasurer. Resident, $1 from county treasurer, $1.15 through justice of the peace. Licenses not issued to minor under 14 years of age, and minor between 14 and 16 must furnish written consent of parent or guardian. Licensee required to wear tag displayed on middle of back and to carry license on person.

Resident citizen and members of family residing upon and cultivating land in State as either owner or lessee may hunt on such land and, with consent of owner, on adjoining land without a license.

Aliens not permitted to hunt or be possessed of dogs or firearms.

Bag limits and possession: One deer (6 to party camping or hunting together), 1 bear (3 to party camping or hunting together), 40 rabbits, 15 hares, 20 squirrels, 1 turkey, 25 quail (Virginia partridge), 15 ruffed grouse, 6 ringneck pheasants, 10 Hungarian partridge, 20 woodcock a season. Five rabbits, 3 hares, 6 squirrels (black, gray, fox), 8 quail (Virginia partridge), 3 ruffed grouse, 3 ringneck pheasants, 4 Hungarian partridge, 6 woodcock, 25 ducks, 8 geese, 8 brant, 25 Wilson snipe, 15 in all of plovers and yellowlegs, 50 sora, 25 in all of other rails, coots, and gallinules a day. Possession of migratory birds permitted during first 10 days of close season; other game during first 30 days thereof.

Sale: Sale prohibited of wild deer, elk, squirrel, rabbit or hare, wild ringneck pheasant, Hungarian partridge taken in the State; and of quail, ruffed grouse (pheasant), wild turkey, reedbirds, and all other migratory birds (wherever taken); provided, bears, raccoons, and blackbirds may be sold at any time.

Export: The export is prohibited of all protected game; provided, a nonresident licensee may take out with him on the same conveyance one day's limit of game. Small game to be carried upon the person in hunting coat or game bag, or as hand baggage, without cover. Large game may be shipped by express when plainly marked. Shipment by parcel post prohibited.

Miscellaneous: Use of automatic guns prohibited.

RHODE ISLAND.

Open seasons:	*Dates inclusive.*
Gray squirrel, hare, rabbit, quail or bobwhite, ruffed grouse or partridge, pheasant	Nov. 1–Dec. 31.
Duck, goose, brant, coot, gallinule	Oct. 1–Jan. 15.
Black-bellied and golden plovers, yellowlegs	Aug. 16–Nov. 20.
Wilson snipe	Oct. 1–Nov. 30.
Woodcock	Nov. 1–Nov. 30.
Rails, other than coot and gallinule	Sept. 1–Nov. 30.

No open season: Deer;[69] dove; Hungarian partridge; swans, wood duck, eider ducks, auks, bitterns, little brown and sandhill cranes, gannet, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, shearwaters, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

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[66] *Pennsylvania:* Seasons may be closed on petition to commission.

[67] Deer and bear may be killed with a single ball only.

[68] See order of Secretary of Agriculture, p. 73.

[69] *Rhode Island:* Deer injuring crops may be killed at any time by the owner or occupant of the premises under written permit from Secretary of State.

Hunting licenses: Nonresident, $10.25; alien, $15.25; resident, $1.25. Issued by city and town clerks.

Not required of resident or his immedate family to hunt on own or leased agricultural lands on which actually domiciled; nonresident owning real estate valued at not less than $500, and nonresident member of club incorporated for hunting or fishing purposes prior to Jan. 1, 1909, which owns real estate assessed for taxation at value of not less than $1,000, may procure license at a fee of $1.25; licenses not issued to minors under 15 years of age. Consent of owner required for hunting on land of another from Dec. 15–Oct. 15.

Bag limits and possession: Fifteen ducks, 8 geese, 8 brant, 6 woodcock, 15 in all of plovers and yellowlegs, 15 Wilson snipe, 15 in all of rails, coots, and gallinules a day, but not more than 15 game birds of all kinds in possession at one time. Possession of waterfowl, coots, and gallinules permitted during first 10 days of close season.

Sale: Sale of all game birds prohibited.

Export: Export prohibited of all game; provided, a nonresident licensee may take out under his license 10 wild fowl or birds in one calendar year, if carried open to view.

SOUTH CAROLINA.

Open seasons:	*Dates inclusive.*
Deer (male)	Sept. 1–Jan. 1.
Bear	Oct. 1–Mar. 15.
Rabbit, squirrel	Sept. 1–Feb. 28.
Quail (partridge), wild turkey	Nov. 24–Mar. 1.[70]
Dove	Oct. 16–Jan. 31.
Duck, goose, brant, coot, gallinule, Wilson snipe	Nov. 1–Jan. 31.
Black-bellied and golden plovers, yellowlegs	Sept. 1–Dec. 15.
Rail, other than coot and gallinule	Sept. 1–Nov. 30.
Woodcock	Nov. 1–Dec. 31.
Reedbird	Aug. 16–Nov. 15.[71]
Blackbird	Oct. 1–Mar. 31.

No open season: Does; ruffed grouse (pheasant) (1925); swans, wood duck, auks, bitterns, little brown, sandhill, and whooping cranes, gannet, grebes, gulls, herons, jaegers, loons, murres, petrels, shearwaters, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses: Nonresident: Game $15.25; fish, $3.25. Issued by county clerk. Resident: Game, State, $3.10; county of residence, $1.10. Issued by county clerk or game warden.

No license required of resident owners, tenants, their children, or, under written permission, their employees, to hunt during open season on own lands.

Consent of owner or manager required to hunt on land of another.

Bag limits: Five deer, 20 wild turkeys a season; 15 squirreds, 15 quail (partridge), 25 doves, 2 turkeys, 25 ducks, 8 geese, 8 brant, 6 woodcock, 25 Wilson snipe, 15 in all of plovers and yellowlegs, 50 sora, and 25 in all of other rails, coots, and gallinules a day. Possession of migratory birds permitted during first 10 days of close season.

Sale: Sale prohibited of deer, quail (partridge), dove, turkey, reedbirds, and all other migratory birds.

Export: Export prohibited of all protected game taken in State; provided, a nonresident licensee may export 2 deer, 50 quail, and 4 turkeys a season, and two days' limit of migratory birds a calendar week, if game is not for sale and packages are marked to show contents.

SOUTH DAKOTA.

Open seasons:	*Dates inclusive.*
Deer (male)	Nov. 1–Nov. 30.
Partridge, grouse, prairie chicken, black-bellied and golden plovers, yellowlegs	Sept. 16–Oct. 15.
Duck, goose, brant, coot, gallinule, Wilson snipe	Sept. 16–Dec. 31.
Woodcock	Oct. 1–Nov. 30.
Rail, other than coot and gallinule	Sept. 16–Nov. 30.

No open season: Does, elk, antelope, mountain sheep, quail, dove, pheasant, upland plover, swans, wood duck, eider ducks, bitterns, little brown, sandhill and whooping cranes, grebes, gulls, herons, loons, shearwaters, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

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[70] *South Carolina:* Season opens on Thanksgiving Day.

[71] See order of the Secretary of Agriculture, p. 73.

Hunting licenses: Nonresident or alien: Big game, $25; small game, $15; issued by game warden or county treasurer. Resident: Big game, $5; small game, $1; special license, small game, $3 (hunting; also authorizes shipment of 50 birds as specified in license); issued by county treasurer. Hunting game birds during open season on own land permitted without license. Unlawful to hunt on cultivated land of another without permission of owner.

Bag limits and possession: One deer a year; 25 ducks, geese, brant, coot, gallinules, sora, and other rails in the aggregate of all kinds (but not more than 8 geese or brant), and 5 of each other species of game birds a day; 50 in all of ducks, geese, or brant, or other aquatic fowl and snipe, and 15 in all of prairie chickens, partridge, grouse, and plover in possession. Possession permitted during open season and five days thereafter.

Sale: Sale of all protected game prohibited; provided, skins, heads, and antlers of deer lawfully killed may be sold.

Export: Export of all protected game prohibited; provided, a nonresident may export 1 deer lawfully killed under permit of State game warden and not more than 10 birds under each of the five coupons attached to his nonresident license; but not more than 50 ducks, 16 geese, 16 brant, 12 woodcock, 50 snipe, 30 in all of plovers and yellowlegs, and 50 in all of rails, coots, and gallinules may be exported by one person in any one calendar week, and if exported by common carrier, tags attached to hunting license must be affixed to each shipment.

TENNESSEE.

Open seasons:	*Dates inclusive.*
Deer in Bledsoe, Cumberland, Grundy, Marion, Sequatchie, and Van Buren Counties	Nov. 1–Dec. 10.
In Cheatham and Dickson Counties	Dec. 20, 1922.
In rest of State	Unprotected.
Squirrel (see exceptions)	June 1–Dec. 31.
Exceptions: In Bledsoe, Cannon, Cumberland, Franklin, Grundy, Lincoln, Loudon, Marion, Marshall, Sequatchie, Sumner, Van Buren, and Warren Counties, unprotected; in Dickson, June 1–Nov. 1; in Dyer, June 1–July 1 and Oct. 1–Jan. 1; in Fayette, Rutherford, June 1–Jan. 1; in Giles, Oct. 15–July 1; in Smith and Wilson, May 1–Mar. 1.	
Rabbit	Unprotected.
Quail or partridge, wild turkey (additional season for gobblers, Apr. 1–25) (see exceptions)	Nov. 15–Dec. 31.
Exceptions: Quail, in Bedford and Moore Counties, Dec. 1–Jan. 1; in Benton, Carroll, Maury, and Putnam, Dec. 1–Jan 31; in Bledsoe, Cumberland, Grundy, Marion, Sequatchie, and Van Buren, Nov. 1–Feb. 1; in Bradley, Campbell, Franklin, Giles, Henry, Hickman, Knox, Montgomery, and Roane, Dec. 1–Feb. 1; in Cannon, Marshall, Lincoln, Lauderdale, and White, Nov. 15–Feb. 15; in Cheatham, Dickson, Lawrence, Loudon, and Obion, Nov. 15–Jan. 15; in Dekalb, Dec. 1–Dec. 31; in Hawkins, Meigs, McMinn, Robertson, and Wilson, Nov. 15–Feb. 1; in Davidson, Nov. 15–Mar. 1; in Fayette, Nov. 22–Feb. 1; in Gibson, Nov. 24–Jan. 31 (1921–22); in Hardeman and Haywood, Dec. 15–Mar. 1; in Henderson, McNairy, and Weakley, Dec. 15–Feb. 15; in Monroe, Dec. 1–Jan. 15; in Sullivan, Nov. 20–Feb. 15; in Washington, Nov. 20–Jan. 1; in Warren, Dec. 1–Mar. 1. Season closed in Union until 1924; Claiborne, no open season.	
Wild turkey, in Bledsoe, Cumberland, Grundy, Marion, Sequatchie, and Van Buren Counties, Nov. 1–Jan. 1, and also on gobblers only, Apr. 1–May 1; in Lincoln, Nov. 1–Mar. 1, and also on gobblers only, Apr. 1–Apr. 25; in Cannon and Sullivan unprotected.	
Dove (see exceptions)	Sept. 1–Dec. 15.
Exceptions: In Dickson, Nov. 15–Dec. 15; in Fayette, Sept. 1–Nov. 1; in Montgomery, Sept. 1–Dec. 1, in Obion, Sept. 1–Sept. 15; in Sullivan, Nov. 20–Dec. 15; in Claiborne, no open season.	

Open seasons—Continued.	*Dates inclusive.*
Duck, goose, brant, coot, mudhen, gallinule, Wilson snipe or jacksnipe (see exception)	Nov. 1–Jan. 31.
Exception: Waterfowl in Haywood County	Dec. 1–Jan. 31.
Black-bellied and golden plovers, yellowlegs	Sept. 1–Dec. 15.
Rail, other than coot and gallinule	Sept. 1–Nov. 30.

No open season: Grouse, ringneck and Mongolian pheasants, woodcock, swans, wood duck, bitterns, sandhill and whooping cranes, grebes, gulls, herons, loons, terns, and all shorebirds (except Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting licenses: Nonresident, $10 (may hunt on own land without license). Resident: State, $2; county, $1 (county licensee may obtain State license for $1). Issued by county clerks. County license not required of residents in Cannon, Hardin, Houston, and Jackson Counties; of residents to hunt squirrels in Dyer, Lincoln, Smith, Wayne, and Wilson Counties or rabbits in Obion; or of residents to hunt squirrels in Clay, Fentress, Jackson, Lawrence, Macon, Marshall, Pickett, and Overton Counties when hunting on uninclosed, or with permission of owner on inclosed, lands.

Owners and tenants may hunt without license on land on which they reside. Unlawful to hunt on tillable or inclosed lands of another without written permission.

Reelfoot Lake: Special license, fee $2, in addition to State license, required of residents. Resident, fish, $1; nonresident, fish, $2; guide or pusher, $1.

Bag limits and possession: Twenty game birds and animals a day, but not more than 8 geese, 8 brant, 15 in all of plovers and yellowlegs a day; in Lauderdale County, 6 squirrels, 12 quail, and 2 turkeys a day or in possession.

Sale: Sale prohibited of migratory birds and of all other protected birds killed in State.

Export: Export of all protected game prohibited; provided, nonresident licensee may take out of State, if carried openly, game birds legally killed by him (except 25 birds only may be exported from Reelfoot Lake), but not more than 50 ducks, 16 geese, 16 brant, 10 Wilson snipe, 30 in all of plovers and yellowlegs, 50 in all of rails, coots, and gallinules, and 50 doves may be exported by one person in any one calendar week.

TEXAS.

Open seasons:	*Dates inclusive.*
Deer (male)	Nov. 1–Dec. 31.
Quail or partridge, chacalaca or Mexican pheasant	Dec. 1–Jan. 31.
Wild turkey gobblers	Mar. 1–Apr. 30.
Doves	Sept. 1–Dec. 15.
Duck, goose, brant, Wilson snipe or jacksnipe, coot, gallinule	Oct. 16–Jan. 31.
Black-bellied and golden plovers, yellowlegs	Oct. 16–Dec. 15.
Rail, other than coot and gallinule	Oct. 16–Nov. 30.

No open season: Antelope, does, sheep (1924); turkey hens, robins; prairie chicken, pinnated grouse, pheasant (except chacalaca), woodcock (1924); swans, wood duck, bitterns, little brown, sandhill, and whooping cranes, gannet, grebes, gulls, herons, jaegers, loons, petrels, band-tailed pigeons, terns, and all shorebirds (except Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting licenses: Nonresident or alien, $15; issued by game, fish, and oyster commissioner, deputies, and county clerks. Resident, $2, not required in county of residence; issued by commissioner, deputies, and county clerks.

Bag limits and possession: Three deer, 3 turkey gobblers a season; 15 in all of quail and chacalaca; 15 doves; 25 in all of waterfowl and shorebirds, but not more than 8 geese, 8 brant, or 15 plovers and yellowlegs; 50 sora and 25 in all of other rails, coots, and gallinules a day. Possession of all game permitted during open season and 10 days thereafter.

Sale: Sale prohibited of all protected game.

Export: Export prohibited of all game, except nonresident licensee may ship game to his home for own use under affidavit that it was lawfully killed and will not be bartered or sold; provided, that not more than two days' limit of migratory birds may be exported in any one calendar week. Game may be shipped to taxidermist for mounting under affidavit that shipper killed the specimen and that it is not being preserved for sale.

UTAH.

Open seasons:[72]	*Dates inclusive.*
Deer (buck, with horns)[73]	Oct. 15–Oct. 25.
Dove	Sept. 1–Sept. 30.
Duck, goose, coot, gallinule (see exceptions)	Oct. 1–Dec. 31.
Exceptions: Waterfowl, in Kane, San Juan, and Washington Counties	Oct. 1–Jan. 15.
Duck in Fish Lake Game Preserve	Oct. 1–Nov. 30.
Rail, other than coot and gallinule	Sept. 1–Nov. 30.

No open season: Does, fawns, elk, antelope, sheep, quail, partridge, prairie chicken, blue grouse, sage hens, pheasants, swans, wood duck, bitterns, sandhill crane, grebes, gulls, herons, loons, band-tailed pigeon, terns, and all shorebirds.

Hunting and fishing licenses: Any male citizen, for game and fish, 12 to 16 years, $1; 16 and over, $2. Females over 18, $1. Aliens prohibited from hunting or fishing in State. Residents under 12 not required to secure license. Issued by State fish and game commissioner or deputy, county clerk, or deputy or authorized agent.

Bag limits: One deer a season (resident citizen only); 25 doves, 25 in all of ducks and geese, but not more than 8 geese a day; 50 sora and 25 in all of other rails, coot, and gallinules a day.

Sale: Sale of all protected game prohibited.

Export: Export of all game prohibited; provided, nonresident licensee may ship out 25 ducks in any one calendar week after they have been examined by the commissioner or one of his deputies and a permit issued therefor.

VERMONT.

Open seasons:	*Dates inclusive.*
Deer (with horns not less than 3 inches long)[74]	Nov. 7–Nov. 19.
Hare, rabbit	Sept. 15–Feb. 28.
Quail	Sept. 15–Nov. 30.
Ruffed grouse or partridge, woodcock	Oct. 1–Oct. 31.
Duck, goose, brant, coot, gallinule	Sept. 16–Dec. 31.
Black-bellied and golden plovers, yellowlegs, English or Wilson snipe (jacksnipe)	Sept. 16–Nov. 30.

No open season: Elk, gray squirrel (1923), moose, caribou, does, fawns, dove, rail; pheasants, European partridge (1932); swans, wood duck, auks, bitterns, sandhill and whooping cranes, grebes, gulls, herons, jaegers, loons, murres, petrels, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses: Nonresident: Game and fish, $10.50; owner of real estate in State to value of $1,000, $1.25; fish, $2.50. Resident: Game and fish, $1.25; game, 75 cents; fish, 75 cents. Issued by town clerks.

Hunting licenses not issued to persons under 16 without written consent of parent or guardian. Owners of farm lands and their resident minor children or tenants may hunt without a license during open season on own lands. Fishing licenses not required of persons under 15.

Bag limits and possession: One deer a season; 4 each of ruffed grouse and woodcock a day, 25 each a season; 5 hares or rabbits, 4 quail, 20 ducks, 8 geese, 8 brant a day; 10 in all of plovers, yellowlegs, and Wilson snipe a day; 25 in all of coots and gallinules a day.

Possession of waterfowl, coots, and gallinules permitted during first 10 days of close season.

Sale: Sale of all protected game birds prohibited; deer may be sold during open season and for a "reasonable time thereafter," and hares and rabbits during the open season. Head and hide of deer legally taken may be sold.

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[72] *Utah:* Commissioner may open and fix seasons and bag limits on quail, pheasants, grouse, sage hens, and doves.

[73] Nonresident not permitted to kill deer.

[74] *Vermont:* Landowner, member of his family, or authorized employee may kill deer doing damage to his fruit trees or crops; but the person under whose direction a deer is so killed must, within 12 hours, report the matter in a signed statement to the nearest fish and game warden. Deer may also be killed at any time in orchard zones established by the commissioner, but such killing must forthwith be reported to the owner of the orchard and the county warden.

Export: Export prohibited of all protected game, except hares and rabbits; provided, a nonresident licensee may export one deer and one day's bag limit of game birds under permit, but must accompany shipment; resident may export (if not for sale) one day's bag limit of game birds under special permit from commissioner. Packages containing game delivered to a common carrier for transportation must be tagged to show the number and kind of such game therein, names of consignor and consignee, station from which shipped, destination, and number of license.

VIRGINIA.

Open seasons:[75]	*Dates inclusive.*
Deer (see exceptions)	Oct. 1–Feb. 1.
Exceptions: In Chesterfield, Mecklenburg, Prince George, and Surry Counties	Oct. 1–Jan. 1.
In Buckingham, Cumberland, Fluvanna, and Goochland Counties	Nov. 1–Jan. 15.
In Bath and Highland Counties (1921)	Nov. 1–Feb. 1.
Elk[76] (except in national forest areas, no open season)	Dec. 15–Dec. 31.
Rabbit[76]	Nov. 1–Feb. 1.
Squirrels[76] (see exceptions)	Aug. 15–Feb. 1.
Exceptions: Brunswick, Caroline, Charles City, Greenesville, James City, New Kent, Spotsylvania, Stafford, Warwick, and York Counties	Nov. 1–Feb. 1.
In Buckingham, Cumberland, Fluvanna, and Goochland Counties	Nov. 1–Jan. 15.
In Loudoun	June 1–Oct. 31.
In Isle of Wight and Southampton	Sept. 1–Jan. 15.
In Rappahannock	Nov. 1–Jan. 31.
In Shenandoah	Aug. 15–Oct. 1.
In Warren	Nov. 15–Jan. 1.
Quail or partridge, pheasant or grouse, wild turkey (see exceptions)	Nov. 1–Feb. 1.
Exceptions: In Buckingham, Cumberland, Fluvanna, and Goochland Counties	Nov. 1–Jan. 15.
West of Blue Ridge (except in Clarke County, Nov. 15–Jan. 1)	Nov. 1–Dec. 31.
Doves (in Buckingham, Cumberland, Fluvanna, and Goochland Counties, Nov. 1–Dec. 15)	Sept. 1–Dec. 15.
Duck, coot, mudhen, gallinule (see exception)	Nov. 1–Jan. 1.[77]
Exception: On Back Bay, Princess Anne County	Nov. 1–Jan. 31.[77]
Goose, brant, Wilson snipe or jacksnipe	Nov. 1–Jan. 31.[77]
Black-bellied and golden plovers, yellowlegs (in Buckingham, Cumberland, Fluvanna, and Goochland Counties, Nov. 1–Nov. 30)	Aug. 16–Nov. 30.
Woodcock	Nov. 1–Dec. 31.
Rail, other than coot and gallinule (in Buckingham, Cumberland, Fluvanna, and Goochland Counties, Nov. 1–Nov. 30)	Sept. 1–Nov. 30.
Reedbird[78]	Aug. 16–Nov. 15.

No open season: Swans, wood duck, eider ducks, auks, bitterns, sandhill crane, fulmars, gannet, grebes, gulls, herons, loons, murres, petrels, shearwaters, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

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[75] *Virginia:* Boards of supervisors may shorten the open season in their counties and make other restrictions not repugnant to law, "and may include in such protection other game not specifically mentioned in this section." (Code 1919, sec. 3356.) These changes are not included in this table.

[76] Elk doing damage to private property may be killed at any time under permit of commissioner of game and inland fisheries. Residents of the State may kill rabbits and squirrels on their own lands at any time. The open season on elk, rabbits, and squirrels in Buckingham, Cumberland, Fluvanna, and Goochland Counties is Nov. 1–Jan. 15.

[77] Wild fowl may not be hunted on Wednesdays, Saturdays, and Sundays on Back Bay, Princess Anne County. Open season on waterfowl, coot, gallinule, and Wilson snipe in Buckingham, Cumberland, Fluvanna, and Goochland Counties, Nov. 1–Jan. 15.

[78] See order of the Secretary of Agriculture, p. 73.

Hunting licenses: Nonresident, $10; alien, $20 (alien owner of real estate resident for five years, same as resident). Resident: State, $3; county of residence, $1. Issued by clerks of circuit and corporation courts.

Nonresident may hunt on own land during open season without a license. Owner, members of family, and tenant of land residing thereon may hunt without license during open season on own or adjoining lands with consent of owner.

Bag limits and possession: One elk a season; 15 quail, 6 grouse (pheasant), 2 wild turkeys a day; 25 ducks, 8 geese, 8 brant a day, but not more than 35 in all a day in Back Bay, Princess Anne County; 15 in all of plover and yellowlegs, 25 Wilson snipe, 6 woodcock, 50 sora, and 25 in all of other rails, coots, and gallinules, 25 doves a day. Possession of geese, brant, Wilson snipe, and dove, and of woodcock (except west of the Blue Ridge) permitted during first 10 days of close season.

Local bag limits are as follows: In Shenandoah County, 15 quail or partridges, 3 pheasants or grouse, and 2 wild turkeys a day. In Brunswick County, 15 quail and 2 turkeys a day.

Sale: Sale of quail or partridge, grouse or pheasant, wild turkey, reedbirds, and all other migratory birds prohibited; and sale of deer during close season prohibited.

Export: Export of all protected game (except sora, rabbits, and squirrels) is prohibited; provided that during open season nonresident may, under his hunting license, take with him out of State, or as baggage on same conveyance, 1 deer, 50 quail or partridges, 10 pheasants or grouse, 3 wild turkeys, 30 waterfowl, and 25 of each or 100 in all of plovers and snipe, if killed or captured by himself, shipped open to view, and plainly labeled with his name and address; but more than 2 days' limit of sora and other migratory birds may not be exported by one person in any one calendar week from any part of State. Any citizen of State may ship from State, as a gift and not for sale (which fact must be stated on shipping tag), 1 deer, 18 quail or partridges, 6 pheasants, 3 wild turkeys, 12 waterfowl, if open to view and plainly labeled with names and addresses of donor and donee and number of each kind of bird so shipped.

Back Bay, Princess Anne County: Nonresident licensee permitted to export as personal baggage 25 ducks, geese, or brant he has lawfully killed, but not for sale or barter; but not more than 16 geese or 16 brant in any one calendar week.

Shenandoah County: Licensee may take with him from county as personal baggage, open to view, if plainly labeled, 30 quail or partridges, 6 pheasants or grouse, 2 wild turkeys a season; and any citizen may ship the same quantity of game, as a gift, if not for sale.

WASHINGTON.

Open seasons: [79]	*Dates inclusive.*
West of Cascades—	
Deer (see exception)	Oct. 1–Nov. 1.
Exception: Does in Clallam, Skagit, Snohomish, and Whatcom Counties, no open season.	
Deer (see exception)	Sept. 1–May 1.
Grouse, prairie chicken, sage hen, quail, scaly partridge, introduced pheasant, Hungarian partridge, wild turkey, and other upland game birds	Sept. 1–Dec. 1.
Duck, goose, brant, coot, black-bellied and golden plovers, Wilson snipe or jacksnipe, yellowlegs	Oct. 1–Jan. 15.
Rail	Oct. 1–Nov. 30.
East of Cascades—	
Deer (male)	Oct. 1–Nov. 15.
Bear	Sept. 1–May 1.
Grouse, prairie chicken, sage hen, quail, scaly partridge, introduced pheasant, Hungarian partridge, wild turkey, and other upland game birds	Sept. 1–Dec. 1.
Duck, goose, brant, coot, Wilson snipe or jacksnipe, black-bellied and golden plovers, yellowlegs	Oct. 1–Dec. 31.[80]
Rail	Oct. 1–Nov. 30.

No open season: [79] Moose, elk (1925); fawns, caribou, mountain sheep, mountain goat, squirrels (gray, black, fox), and dove; swans, wood duck, eider ducks, auklets, auks, bitterns, little brown and sandhill cranes, fulmars, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, band-tailed pigeon, puffins, shearwaters, terns, and all shore birds (except Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

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[79] *Washington:* County game commission, with consent of Director of Fisheries and Game, may shorten, close, or open season and fix bag limits on upland game birds.

[80] No open season on waterfowl on Columbia or Snake Rivers or within one-fourth mile of their shores in counties of Benton, Columbia, Douglas, Franklin, Garfield, Grant, Kittitas, Klickitat, Walla Walla, Whitman, and Yakima.

Hunting and fishing licenses: Nonresident or alien: Hunting and fishing, State, $10; fishing, county, $2.50. Resident: State, $7.50; county, $1.50. Issued by county auditors. Aliens must have permit to carry firearms.

No license required of women and persons under 16 to fish, if residents.

Bag limits and possession: One buck deer in counties east of Cascades. Two deer (1 buck in Clallam, Skagit, Snohomish, and Whatcom) in counties west of Cascades.

Five in all of partridge, grouse, prairie chickens, Hungarian partridge, Chinese or English pheasant a day or in possession; 10 quail a day; 10 upland birds, but in no event to include more than 5 upland birds other than quail, and 25 in all of upland birds a week. In Kittitas County 2 male Chinese or English pheasants in bag of 5 upland birds; 20 ducks, geese, brant, golden plover, yellowlegs, Wilson snipe a week (week ends at midnight Saturday), but not more than 8 geese, 8 brant, 15 in all of plovers and yellowlegs a day; 30 ducks, geese, brant in possession; 50 sora and 25 in all of other rails, coots, and gallinules. Possession during close season permitted upon filing with county game commission description and number of each kind of game, which may be tagged or stamped by commission for identification, but migratory birds shall not be possessed longer than the first 10 days after close of open season.

Sale: Sale of all protected game prohibited; provided, game imported under license (fee, $25) may be sold by keeper of hotel, restaurant, boarding house, club, retail dealer, etc., under $5 license, and regulations of director of fisheries and game.

Export: Export of all protected game prohibited.

WEST VIRGINIA.

Open seasons:	*Dates inclusive.*
Rabbit (except on own land at any time)	Oct. 1–Dec. 31.
Squirrel	Sept. 1–Nov. 30.
Ruffed grouse (pheasant), wild turkey [81]	Oct. 15–Nov. 30.
Quail (Virginia partridge) [82]	Nov. 1–Nov. 30.
Duck, goose, brant	Oct. 15–Dec. 31.
Coot, gallinule	Sept. 16–Dec. 31.
Wilson snipe or jacksnipe	Oct. 15–Dec. 14.
Black-bellied and golden plovers, yellowlegs	Sept. 16–Dec. 31.
Woodcock	Oct. 15–Nov. 30.
Rail (ortolan), other than coot and gallinule	Sept. 16–Nov. 30.

No open season: Deer (1923); elk (1931); dove, imported pheasants, capercailzie, and other introduced foreign game birds; swans, wood duck, bitterns, sandhill crane, grebes, gulls, herons, jaegers, loons, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses: Nonresident, game and fish, $15; resident, game and fish, $1; issued by county clerk. Aliens not permitted to hunt. License not required of minor under 15. Landowner, his resident children and tenants, may hunt or fish on own land during open season without a license. Unlawful to hunt or fish on inclosed or improved lands of another without written permission of owner.

Bag limits and possession: Eight squirrels a day, 60 a season; 10 quail a day, 60 a season; 4 ruffed grouse a day, 20 a season; 1 wild turkey a day, 4 a season; 25 ducks, 8 geese, 8 brant, 6 woodcock, 25 Wilson snipe, 15 in all of plovers and yellowlegs, 50 sora, and 25 in all of other rails, coot, and gallinules a day. Possession of migratory birds permitted during first 10 days of close season; other game legally taken may be possessed at any time.

Sale: Sale prohibited of all protected game, except rabbits may be sold during open season.

Export: Export prohibited of elk, deer, squirrels, quail, ruffed grouse (pheasant), wild turkey, geese, brant, ducks. Not more than two days' limit of migratory birds (except waterfowl) may be exported by one person in any one calendar week.

Miscellaneous: Unlawful to discharge firearms across any public road, within 400 feet of any schoolhouse or church, within 500 feet of a dwelling house, or on or near any park or place where people gather for pleasure.

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[81] *West Virginia:* The sex and number of wild turkeys killed in State must be reported to commission in December of each year.

[82] Commission may change the dates in any county for the open season on quail, but may not permit more than 30 days' hunting.

WISCONSIN.

Open seasons:	*Dates inclusive.*
Deer (male, with horns not less than 3 inches long) in Pierce, Barron, Eau Claire, Clark, Wood, Lincoln, Langlade, Shawano, Oconto and all counties north thereof (except Marathon)	Nov. 13–Nov. 22.
In Marathon and rest of State, no open season.	
Rabbit (see exception)	Oct. 25–Jan. 15.
Exception: Crawford, Grant, Richland, and Vernon Counties, unprotected.	
Jack rabbit in Trempealeau County, Oct. 15, 1923.	
Squirrels (see exception)	Oct. 15–Jan. 1.
Exception. In Dodge, Kenosha, Milwaukee, Ozaukee, Racine, Washington, and Waukesha Counties, no open season.	
Partridge or ruffed grouse, spruce hen (see exception)	Oct. 4–Oct. 8.
Exception: In Calumet, Manitowoc, and Winnebago Counties, no open season.	
Prairie chicken or pinnated grouse, sharp-tailed grouse	Sept. 20–Sept. 24 [82a]
Hungarian partridge in Jefferson and Waukesha Counties only	Sept. 7–Sept. 11.
Duck, coot or mud hen, gallinule, Wilson snipe or jacksnipe, black-bellied and golden plovers, yellowlegs	Sept. 16–Dec. 20.
Goose, brant	Sept. 16–Dec. 31.
Rail, other than coot and gallinule	Sept. 16–Nov. 30.

No open season: Elk, moose, quail, pheasants (Chinese, English, Mongolian), Hungarian partridge (except as above), woodcock, dove, swans, wood duck, eider ducks, auks, bitterns, little brown, sandhill, and whooping cranes, grebes, guillemots, gulls, herons, loons, murres, terns, and all shore birds (except Wilson snipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses: Nonresident: All game, $50; all game (except deer), $25; all fish, $3; all fish (except trout), $2 (not required in outlying waters or of person under 16); settlers, $1; guide, $1. Issued by commission. Resident: Game, $1 (deer tag, 10 cents additional). Issued by county clerks.

Hunting licenses not issued to persons under 15 or to aliens. Hunting prohibited in fields of growing grain or on lands of another without consent of owner.

Bag limits and possession: One deer a season; squirrels, 5 a day; rabbits, 5 a day in counties where protected; other counties no limit; 5 partridge and spruce hens a day; 5 prairie chickens and sharp-tailed grouse a day; 2 Hungarian partridges a day; 8 geese, 8 brant a day. Duck (including coot or mud hen), 15 a day; plovers, snipe, rail, rice hen, 15 a day; 15 yellowlegs, but not more than 15 in all of plovers and yellowlegs a day.

Possession at any time of deer duly tagged permitted for private use by person killing it. Possession at any time prohibited of game by person without hunting license or scientist's certificate.

Sale: Sale of all protected game prohibited (except rabbit). Rabbits may be sold during open season.

Export: Export of all protected game prohibited, except nonresident licensee may transport, during last 10 days of November, 1 deer duly tagged if he accompanies shipment and may take in his personal possession, openly, a mixed bag of not more than 20 game birds legally killed, but not more than the bag limit for one day of any one variety.

Export permitted of specimens of birds and animals (except deer) taken under permits from State authorities and, if migratory birds are included, from Secretary of Agriculture for scientific purposes. Park boards allowed to ship, under permit of State conservation commission, live animals and game birds for park purposes.

WYOMING.

Open seasons: [83]	*Dates inclusive.*
Deer (with horns)	Sept. 15–Oct. 15.
Elk in Lincoln, Park, and Fremont Counties (except between Roaring Fork Creek and Big Sandy River on west slope of Wind River Mountains in Bridger National Forest, and north of Big Wind River and south of Sweetwater River in Fremont County)	Sept. 15–Nov. 15.

[82a] *Wisconsin:* In Barron, Calumet, Crawford, Dane, Dunn, Fond du Lac, Grant, Green, Iowa, Jefferson, Kenosha, LaCrosse, Lafayette, Lincoln, Manitowoc, Milwaukee, Monroe, Oneida, Ozaukee, Polk, Portage, Racine, Richland, Rock, Sauk, Vernon, Walworth, Washington, Waukesha, Waupaca, and Winnebago Counties, no open season.

[83] *Wyoming:* The State Game and Fish Commission may suspend open season in any county or district of State on any species of game when threatened with extinction.

Open seasons—Continued.	*Dates inclusive.*
Sheep (mature male with horns not less than one-half curl) in Lincoln, Park, and Fremont Counties only	Sept. 15–Nov. 15.
Sage grouse	Aug. 1–Aug. 15.
Duck, goose, coot, gallinule, black-bellied and golden plovers, Wilson snipe, yellowlegs	Sept. 16–Dec. 16.
Rail, other than coot and gallinule	Sept. 1–Nov. 30.

No open season: Elk (except as above), buffalo, does and fawns, moose,[84] antelope,[84] quail, Mongolian pheasants (1925); grouse (other than sage grouse) (1923); dove, swans, wood duck, bitterns, little brown and sandhill cranes, grebes, gulls, herons, loons, terns, and all shore birds (except Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses: Nonresident: General, $50 (not issued to minor under 16; authorizes hunting of bears Sept. 15–Nov. 15); nonresident hunting big game must be accompanied by a guide, but not more than 3 may hunt under one guide; birds, $5; fish, $3 (not required of minor under 12). Bear, $25 (issued by Commissioner; authorizes killing of 3 bears at such times as may be designated). Alien: fish, $5; resident alien, fish, $3. Resident: General, $2.50 (not issued to minor under 16); birds, $1.50 (not issued to minor under 14); fish, $1 (not required of G. A. R. veterans, or minors under 12 years of age). Guide: Citizen only, $25 (bond, $500—may guide party of 3 nonresidents at one time). Permit to photograph game or birds, under supervision of commission, Jan. 1–April 30, $5. Permit to hunt bear in State game preserves, $5; permit to hunt bear in National Forests outside of State game preserves, $5, and $1 for each dog. Licenses issued by commissioner, justice of peace, assistant and deputy wardens, and county and city clerks. Unlawful to hunt on inclosed lands of another without consent of owner. Licensee required to make sworn statement, on or before December 1, showing whether or not any game animals have been killed by him, and if so, the number and sex of each kind, time and place of killing, and name of guide present when killing was done.

Bag limits and possession: One deer, 1 elk, 1 sheep, a season; 4 sage hens, 8 geese, 15 other game birds a day; possession limited to 15 game birds of which not more than 6 may be sage hens.

Sale: Sale of all game of State prohibited; provided, the sale of game (except edible portion) is permitted when properly tagged. Justice of peace issues tags (fee, 50 cents) under affidavit that game was lawfully captured or killed. No sale of migratory birds permitted.

Export: Export of all protected game prohibited; provided, game may be exported if properly tagged by a justice of the peace, fee 50 cents. Game tags issued under affidavit that game was lawfully killed, and, if for edible portion, that it is not for sale. Smithsonian Institution or other well-known scientific institutions may export any game animals and birds under permit of State game commissioner. Exchange of game animals and birds for liberation in Wyoming allowed under permit of the State game commission. Not more than 50 ducks, 16 geese, 16 brant, 50 Wilson snipe, 30 in all of plovers and yellowlegs, or 50 in all of rails, coots, and gallinules may be exported by one person in any one calendar week.

Canada.

Under the act of August 29, 1917, as amended in 1919, to give effect to the migratory-bird treaty between the United States and Great Britain the Governor General in council has promulgated regulations for the protection of migratory birds in Canada.[85] These regulations restrict the hunting of migratory game birds not protected throughout the year to a period not exceeding three and one-half months between September 1 and February 28, inclusive, in all except the Maritime Provinces, where the three and one-half months open season on shorebirds opens August 15 and closes November 30. Other provisions of the regulations fix bag limits on migratory game birds and prescribe the manner in which they may be taken and the appliances that my be used therefor.

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[84] State Game and Fish Commission may permit bull moose and buck antelope to be killed in certain sections, to be designated, from September 15 to October 31. Commissioner may issue not to exceed 100 permits for each species when authorized. Bull moose: Fees, resident citizen, $50; nonresident or noncitizen, $100; limit, 1 a season. Buck antelope: Fees, resident citizen, $25; nonresident or noncitizen, $50; limit, 1 a season.

[85] Full text of the regulations, as amended May 11, 1920, will be found on pages 67–72.

Canada also has a general law prohibiting export of deer (except those raised on private preserves), wild turkey, quail, partridge, prairie fowl, and woodcock, but, subject to Provincial laws, a nonresident licensee, under permit of the collector of customs of the port from which export is made, may export, during the open season in the Province where killed or within 15 days thereafter, the carcasses or parts thereof of one moose and three deer, except from Yukon Territory the hides and heads only of 2 moose, 6 caribou, and 6 deer may be exported, but no person may export any moose or deer or parts thereof on more than two occasions during one calendar year. The ports of export are Halifax and Yarmouth, Nova Scotia; McAdams Junction, St. John, and St. Stephens, New Brunswick; Montreal, Quebec, Sherbrooke, Beebe Junction, and St. Armand, Quebec; Bridgeburg, Kingston, Ottawa, Port Arthur, Prescott, Niagara Falls, Sarnia, Sault Ste. Marie, Toronto, and Windsor, Ontario; Emerson, Manitoba; North Portal, Saskatchewan; Coutts, Alberta; Kingsgate and Wanita, British Columbia; White Horse, Yukon Territory; and at all other customs ports and outports on the frontier of the United States; and such others as the minister of customs may designate.

ALBERTA.

Open seasons:[56]	*Dates inclusive.*
Deer, moose, caribou (must have horns at least 4 inches long)	Nov. 1–Dec. 14.
Sheep (male), goat (must have horns at least 4 inches long)	Sept. 1–Oct. 31.
Grouse, partridge, prairie chicken, ptarmigan	Oct. 15–Oct. 31.
Hungarian partridge	Oct. 1–Oct. 31.
Duck, goose, brant, Wilson snipe or jacksnipe, black-breasted and golden plovers, yellowlegs, rail, coot, gallinule	Sept. 1–Dec. 14.

No open season: Elk or wapiti, buffalo, females of deer, moose, sheep, young of all big game with horns less than 4 inches in length, antelope (1925); pheasant, dove, swans, wood duck, bitterns, little brown, sandhill, and whooping cranes, grebes, gulls, herons, jaegers, loons, terns, and all shorebirds (except Wilson snipe or jacksnipe, black-breasted and golden plovers, and yellowlegs).

Hunting licenses: Nonresident: General, $25; bird, $5. Resident: Big game, $2.50 (farmers or their sons residing on own land, big game, $1); birds, $2.25; not required of farmer or member of family residing with him on farm nor of residents residing north of fifty-fifth parallel; guide, $2.50 (guide may not act for more than three persons on any trip); market hunter, $5; game dealer, $10. Taxidermist, $5. Issued by minister of agriculture. Head of family residing north of latitude 55° may take one head of big game (except elk or buffalo) without big-game license.

Bag limits: Deer, moose, caribou, 1 of each species, 2 sheep, 2 goats a season; grouse, partridge, prairie chicken, ptarmigan, 10 a day, 50 a season; Hungarian partridge, 10 a day, 50 a season; 30 ducks a day, 200 a season; 15 geese, 15 brant, 25 in all of rails, coot, and gallinules, 25 Wilson snipe, and 15 in all of plovers and yellowlegs a day.

Sale: Sale of grouse, partridge, prairie chicken, ptarmigan, and Hungarian partridge prohibited. Other game birds may be sold under license during open season. The migratory game birds and the flesh of big game may be sold under $10 license. Heads of big game before being sold must be stamped by minister of agriculture at fee of $5 for elk, caribou, moose, sheep; and $2 for deer, antelope, and goat.

Export: Export of all protected game prohibited, except minister of agriculture may grant permits for export of game at the rate of $5 for each head of big game and $1 per dozen for game birds. The holder of a general nonresident license may take with him out of the Province as trophies heads, skins, and hoofs of big game legally killed by him. Any person may export mounted or branded heads at a fee of $1 for each head. Export of migratory birds prohibited during close season.

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[56] *Alberta:* North of latitude 55° any game animal or bird, except elk and buffalo, may be killed at any time if needed for food, under proper license.

BRITISH COLUMBIA.[87]

[1921 regulations on upland game birds not received.]

Open seasons: [87]	*Dates inclusive.*
Moose (male) in Atlin, Fort George, Omineca, and Cariboo Electoral Districts	Sept. 1–Dec. 15.
In Columbia Electoral District (1921)	Oct. 1–Nov. 15.
In rest of Province	No open season.
Caribou (male) (see exception)	Sept. 1–Dec. 15.
Exception: South and east Canadian Northern Pacific Railway	No open season.
Mountain sheep (male), north Grand Trunk Pacific Railway; also in Lillooet Electoral District, west of Fraser River and north of Churn Creek	Sept. 1–Nov. 15.
In Columbia, Cranbrook, and Fernie Electoral Districts	Oct. 1–Nov. 15.
In rest of Province	No open season.
Mountain goat	Sept. 1–Dec. 15.
Bear [87] (see exception)	Sept. 1–June 30.
Exception: On Vancouver Island	Nov. 1–June 30.
Duck, goose, brant, rail, coot, gallinule, Wilson snipe or jacksnipe, black-breasted and golden plovers, yellowlegs (1921):	
Northern and Eastern Districts [88]	Sept. 3–Dec. 18.
Western District [88]—north of fifty-first parallel	Sept. 10–Dec. 25.
Duck, rail, coot, gallinule, Wilson snipe or jacksnipe, black-breasted and golden plovers, yellowlegs:	
Western District—south of fifty-first parallel	Oct. 15–Jan. 30.
Goose, brant:	
Western District—south of fifty-first parallel	Nov. 12–Feb. 27.

No open season: Buffalo, elk, young of deer and goat, and females and young of moose, caribou, and sheep; wood duck, band-tailed pigeon, auklets, auks, bitterns, fulmars, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, terns, and all shorebirds (except curlew, Wilson snipe, black-breasted and golden plovers, and yellowlegs). Seasons on swans, cranes, and curlew fixed by provincial authorities.

Hunting and fishing licenses: Nonresident: General, $25 and $25 additional for each grizzly bear, moose, sheep, wapti, or caribou, $15 additional for each black or brown bear, mountain goat, or mule deer, and $5 additional for every deer of any other species shot by him; bear, January 1–July 1, $25; angling, season $5, or $1 per day up to five days; British subject, birds, $5 per week. Resident and members of army, navy, air forces, or militia on duty in Province: Deer and birds, $2.50; big game and birds, $5. Big game, birds, and trapping, $10 (holder must report within two months after expiration of license number of big game or fur animals taken); guide, $5. Taxidermist, $5. Issued by warden or any person authorized by him.

No fee required of farmer holding over 10 acres of land or member of family for license to hunt birds and deer on land on which he resides. Free license granted to prospector under certain conditions upon production of free miner's certificate. No license issued to person under 18 without written consent of parent or guardian, and then to hunt with firearms only under supervision of licensed adult. Unlawful to hunt on cultivated, cleared, or inclosed land without owner's consent.

Badge to be worn by licensee. Firearms not to be carried without license.

Bag limits and possession: Three deer of any species, 4 in all; 1 elk, 1 moose, 2 caribou, 2 goats, 2 sheep (1 in Columbia, Cranbrook, Fernie, and Lillooet electoral districts), 2 grizzlies and 3 bear of any other species a season; 20 ducks a day, 250 a season; 10 geese a day, 50 a season; 15 brant, 25 in all of rail, coot, and gallinule, 25 Wilson snipe, and 15 in all of plovers and yellowlegs a day. (Limits on other species fixed by orders in council.) Game may be possessed for two weeks after close of open season. Unlawful for a dealer in skins to possess the skin of any wapiti (elk) or deer.

Sale: Sale of migratory game birds prohibited and of all other game, except under regulations of lieutenant governor in council. Regulations permit sale of moose and caribou, bulls over one year of age, in Atlin, Caribou, Fort George, and Omineca electoral districts, from Oct. 1–Dec. 15, and bear, throughout Province, during open seasons.

Sale of big game without head attached and game birds without plumage prohibited. Heads of big game killed without and imported into Province may be sold when branded. Fees: Moose and elk, $5; mountain sheep, $4; caribou, $3.

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[87] *British Columbia:* Open seasons on big game and upland game fixed annually by order in council, copies of which may be had from the secretary of the game conservation board, Vancouver, British Columbia. Unlawful to trap bear.

[88] For definition of districts see Regulation 2, pp. 74–75.

Export: Export prohibited of all protected game except under permit of the Game Conservation Board.

Miscellaneous: Use of automatic guns prohibited. Pump guns capable of holding only one cartridge in magazine may be used. Unlawful to discharge, carry, or possess any loaded shotgun or rifle in any vehicle on a highway or railway.

MANITOBA.

Open seasons:	*Dates inclusive.*
Deer, moose, caribou, or reindeer, antelope or cabri (males)	Dec. 1–Dec. 10.
Ptarmigan	Oct. 1–Oct. 20.
Prairie chicken, partridge, grouse	Oct. 15–Oct. 22.
Duck, goose, brant, rail, coot, gallinule, Wilson snipe, black-breasted and golden plovers, yellowlegs, woodcock	Sept. 15–Nov. 30.

No open season: Bison or buffalo, elk or wapiti, females and young of big game, dove; quail, pheasant, Hungarian partridge, introduced game bird (1927); swans, wood duck, eider ducks, bitterns, little brown, sandhill, and whooping cranes, grebes, gulls, herons, jaegers, loons, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-breasted and golden plovers, and yellowlegs).

Hunting licenses: Nonresident alien, big game, $25; birds, $25. Nonresident British, big game, $15; birds, $10. Resident, big game, $4; birds, $1. Issued by minister of agriculture. Hunting prohibited on inclosed or cultivated land or land covered by buildings or water, without consent of owner. No license required of farmers or members of family to hunt on farm on which they reside. Holder of resident bird license required, on or before December 15, to return license with sworn statement that he has not violated the act.

Bag limits and possession: One in all of deer, moose, caribou, and antelope a season; 15 ptarmigan a day, 50 a season; prairie chicken, partridge, grouse, 25 in all a season; 20 ducks a day in September, 40 a day in October and November, 250 a season; 10 geese, 15 brant, 25 in all of rails, coot, and gallinules, 10 woodcock, 25 Wilson snipe, and 15 in all of plovers and yellowlegs a day. Possession of ptarmigan, prairie chicken, partridge, and grouse allowed for 10 days, and of ducks for four months after close of hunting season. Venison for private use may be possessed at any time on proof of legal killing. Heads and hides of big game legally taken, within or without Province, may be possessed at any time.

Sale: Sale prohibited of deer, moose, caribou, antelope (except heads and hides), and all protected game birds.

Export: Export prohibited of all protected game except under permit issued by department of agriculture. No permit shall be issued for export of ptarmigan, prairie chicken, partridge, grouse, geese, ducks, or entire carcass of any moose, caribou, or deer; provided, nonresident licensee under permit issued free may export carcass of moose, caribou, or deer, and not more than 50 geese and 50 ducks killed by him. (No duck shall be exported before Oct. 1.) Export of migratory birds prohibited during close season.

Miscellaneous: Hunters must wear complete outer suit and cap of white material. Automatic guns prohibited in hunting waterfowl and ptarmigan.

NEW BRUNSWICK.

Open season:	*Dates inclusive.*
Deer (see exception), moose (bulls) (1921)	Sept. 15–Nov. 30.
Exception: Deer on Grand Manan, Campobello,[89] and Deer Islands	No open season.
Duck, goose, brant, rail, coot, gallinule	Sept. 15–Dec. 31.
Woodcock, jacksnipe or Wilson snipe	Sept. 15–Nov. 30.
Black-breasted and golden plovers, yellowlegs	Aug. 15–Nov. 30.

No open season: Caribou (1924); calf under 3 years and cow moose; pheasant; partridge,[90] swans, wood duck, eider ducks, auks, bitterns, fulmars, gannet, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, black-breasted and golden plovers, and yellowlegs).

Hunting licenses: Nonresident: General, $50; bird, $15; trout, $10; salmon, $25. Resident: Big game, $3; sinkbox for waterfowl, $1; taxidermist, $1; guide, $1; camp help, $1. Big game license not issued to person under 18. Issued by minister of lands and mines and authorized vendors. Nonresident licensee must have registered guide, and not more than 2 hunters may accompany one guide.

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[89] *New Brunswick:* Minister of Lands and Mines may issue license (fee, $1) to resident of Grand Manan or Campobello Island to take one deer Dec. 1–Dec. 10.

[90] Season on partridge may be opened by order in council.

Bag limits and possession: Two deer, 1 moose (lumber camp limited to 2 moose and 4 deer) a season; 6 partridges a day, 20 a season; 25 ducks, 15 geese, 15 brant, 25 in all of rails, coot, gallinules, 10 woodcock, 25 Wilson snipe, and 15 in all of plovers and yellowlegs a day. Game may be kept for personal use in cold storage during close season under permit.

Sale: Sale of all game prohibited, except that a licensed hunter may sell moose or deer which he has lawfully killed. Keepers of hotels, inns, etc., may serve game during open season and 15 days thereafter. Hides and skins of animals may be sold under license by nonresidents or aliens, fee, $25; and residents, fee, $5.

Export: Export of all game prohibited, except that minister of lands and mines may issue license to export game alive or dead.

Miscellaneous: Automatic guns prohibited in hunting big game and waterfowl.

NORTHWEST TERRITORIES.[91]

Open seasons:[92]	*Dates inclusive.*
Deer and moose (males only), mountain goat	Sept. 1–Apr. 1.
Mountain sheep, caribou	Aug. 1–Oct. 1. Dec. 1–Apr. 1.
Partridge, prairie chicken, ptarmigan, and other grouse	Sept. 1–Jan. 1.
Duck, goose, brant, rail, coot, gallinule, Wilson snipe, black-breasted and golden plovers, yellowlegs	Sept. 1–Dec. 14.

No open season: Buffalo or bison; musk ox, wapiti or elk, does, cow moose; females of caribou, sheep, and goat with young, and young of any of such animals; swan (1928); wood duck, eider duck (1923). Hunting or trapping prohibited on Victoria and Banks Islands; auks, bitterns, little brown and sandhill cranes, fulmars, grebes, guillemots, gulls, jaegers, loons, murres, terns, and all shorebirds (except Wilson snipe or jacksnipe, black-breasted and golden plovers, and yellowlegs).

Hunting and trapping licenses: Nonresident, $50; nonresident British subject, $25; resident, $2; trading or trafficking in game; nonresident, $100; nonresident British subject, $50; resident, $5. Issued by commissioner of Dominion parks. Native-born Indians, Eskimos, or half-breed bona fide residents of Northwest Territories may hunt without a license.

Bag limits: Two bull moose, 2 male deer, 4 caribou; mountain sheep, 2 of any species, 3 in all; mountain goat, 2 of any one species a season; 25 ducks, 15 geese, 15 brant, 25 in all of rails, coot, and gallinules, 25 Wilson snipe, and 15 in all of plovers and yellowlegs a day.

Sale: Sale of protected game during close season prohibited.

Export: Export of the meat of any game prohibited.

NOVA SCOTIA.

Open seasons:	*Dates inclusive.*
Deer, male (except on Cape Breton Island, no open season)[93]	Oct. 16–Oct. 31.
Moose, bulls (except on Cape Breton Island, no open season)[93]	Oct. 1–Nov. 15.
Caribou, bulls, in Inverness and Victoria Counties only[93]	Sept. 16–Oct. 15.
Hare, rabbit (see exception)	Nov. 1–Feb. 28.
Exception: On Cape Breton Island	Dec. 1–Feb. 28.
Ruffed grouse (birch partridge)	Oct. 15–Nov. 14.
Duck, goose, brant, rail, coot, gallinule (see exception)	Sept. 15–Dec. 31.
Exception: Black duck	Oct. 15–Dec. 31.
Black-breasted and golden plovers, yellowlegs	Aug. 15–Nov. 30.
Woodcock, Wilson snipe	Sept. 15–Nov. 30.

No open season: Females and young of deer, moose, and caribou, Canada grouse (spruce partridge), pheasant. Swans, wood duck, eider ducks, auks, bitterns, fulmars, gannet, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, black-breasted and golden plovers, and yellowlegs).

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[91] "*Northwest territories*" means the northwest territories formerly known as Ruppert's Land and the Northwestern Territory (except such portions thereof as are included in the Provinces of Ontario, Quebec, Manitoba, Saskatchewan, and Alberta and the Yukon Territory), together with all British territories and possessions in North America and all islands adjacent thereto not included within any Province, except the Colony of Newfoundland and its dependencies.

[92] Indians, Eskimos, bona fide inhabitants, explorers, and surveyors may take game, except buffalo, musk ox, or elk, and the eggs of birds when actually needing them to prevent starvation. Indians and Eskimos may take musk ox for such purposes.

[93] *Nova Scotia:* Every person killing a deer, moose, or caribou must, within 10 days, make a written and signed report to the chief game commissioner showing his address and when and where such animal was killed.

Hunting licenses: Nonresident: All game, $40; birds and small game, except woodcock and snipe, $15; nonresident paying taxes equal to license fee, $5; military or naval officer stationed in Province, $5; resident alien, $10; guide, resident, $2. Game dealer, $10. Issued by provincial secretary, game commissioners, and municipal clerks.

Bag limits and possession: One deer, 1 moose, 1 caribou a season; 5 ruffed grouse, 25 ducks, 15 geese, 15 brant, 25 in all of rails, coot, and gallinules, 10 woodcock, 25 Wilson snipe, and 15 in all of plovers and yellowlegs a day. The green hide or fresh meat of big game may be possessed as follows: Moose, October 1 to November 29; deer, October 16 to November 3; caribou, September 16 to October 30.

Sale: Sale prohibited of deer, caribou, pheasant, blackcock, capercailzie, Canada grouse (spruce partridge), chukar partridge, ruffed grouse, woodcock, Wilson snipe, or other shorebirds.

Moose (meat only) may be sold from October 4 to October 19 under certificate showing lawful killing; rabbit, December 4 to February 1; any game bird other than those above mentioned during the open season, with the exception of the first three days.

Export: Export prohibited of all protected game, except holder of nonresident general license may ship out of Providence under license tag 1 moose lawfully shot by himself. Mounted heads and dressed skins and live mammals or birds for propagating or scientific purposes may be exported under permit from chief game commissioner.

Miscellaneous: Unlawful to use rifle or gun loaded with bullet to shoot waterfowl.

ONTARIO.

Open seasons:[94]	*Dates inclusive.*
Deer, moose, caribou (bulls only) (cows and calves under 1 year of age, no open season) (see exception)	Nov. 5–Nov. 20.
Exception: North of French and Mattawa Rivers	Oct. 25–Nov. 30.
Hare[95]	Oct. 15–Nov. 15. Dec. 23–Jan. 2.
Ruffed grouse or partridge	Nov. 5–Nov. 20.
Capercailzie	Sept. 15–Dec. 15.
Woodcock	Oct. 15–Nov. 14.
Duck, geese, brant, black-breasted and golden plovers, yellowlegs, jacksnipe or Wilson snipe, rail, coot, gallinule	Sept. 1–Dec. 14.

No open season: Fawns, elk, or wapiti; squirrel (black or gray), quail, pheasant, prairie fowl, wild turkey (1923); dove, swans, wood duck, eider ducks, auks, bitterns, little brown, sandhill, and whooping cranes, gannet, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, terns, and all shorebirds (except woodcock, Wilson snipe, black-breasted and golden plovers, and yellowlegs).

Hunting licenses: Nonresident: General, $25. Resident: Moose and caribou, $5; deer, $3. Farmers living upon and tilling their own land in districts of Haliburton, Muskoka, Parry Sound, Nipissing, and Manitoulin and that part of Province lying north and west thereof may kill during open season one deer for own use without license. Guide, $2. Issued by department of game and fisheries.

Bag limits and possession: One deer, 1 bull moose, 1 caribou a season; 5 ruffed grouse or partridge a day, 10 a season; 25 ducks a day, 200 a season; 15 geese, 15 brant, 25 in all of rails, coot, and gallinules, 10 woodcock, 25 Wilson snipe, and 15 in all of plovers and yellowlegs a day. Two or more persons hunting together under license may kill an average of 1 deer each. Possession permitted during open season and until March 31 following of all game except migratory birds.

Sale: Sale of migratory game birds, quail, and ruffed grouse or partridge prohibited. All other native game may be sold during the open season by the person killing it, and by dealers during open season and until the following January 1, under license; hotels, restaurants, and clubs under license may sell during closed season to March 31. Imported game may be sold under special regulations and licenses. Game breeders may sell animals for breeding purposes under permit.

Export: The export of all wild game animals and birds is prohibited; provided, 1 deer, 1 bull moose, 1 bull caribou, and 100 ducks may be exported under nonresident hunting license if shipping coupon and, if required, affidavit of lawful killing be attached and contents of packages be open to view. Lawfully imported game and deer, moose, elk, or caribou in private ownership may be exported. Minister may issue permit for the exoprt of game, dead or alive, at any time, except migratory birds during close season.

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[94] *Ontario:* Lieutenant governor in council may alter close seasons in region north and west of French River, Lake Nipissing, and Mattawa River, and in the vicinity of Rondeau Park, and close for a definite period seasons for any game animal or nonmigratory game bird whose numbers have diminished.

[95] Hares may be killed during close season by any means other than shooting.

Miscellaneous: Use of automatic guns prohibited. Unlawful to enter with gun or dog into growing or standing grain without consent of owner.

PRINCE EDWARD ISLAND.

Open seasons:	*Dates inclusive.*
Hare, rabbit	Nov. 1–Feb. 1.
Partridge (in alternate years, 1921, 1923, etc.)	Oct. 15–Nov. 15.
Duck, goose, brant, rail, coot, gallinule	Sept. 1–Dec. 14.
Woodcock, jacksnipe or Wilson snipe	Sept. 15–Nov. 30.
Black-breasted and golden plovers, yellowlegs	Aug. 15–Nov. 30.

No open season: Swans, wood duck, eider ducks, bitterns, little brown crane, gannet, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, shearwaters, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-breasted and golden plovers, and yellowlegs).

Hunting licenses: Nonresident, $15. If applicant pays taxes on real estate valued at $325, fee $5; sons and brothers of residents returning for visit, $2.50; guest, $2. Issued by game inspectors and tax collectors. Hunting on inclosed lands without permission of owner prohibited.

Bag limits: Twenty-five ducks, 15 geese, 15 brant, 25 in all of rails, coot, and gallinules, 10 woodcock, 25 Wilson snipe, and 15 in all of plovers and yellowlegs a day.

Sale: Game lawfully killed may be sold, except migratory birds may not be sold during close season.

Export: Export prohibited of all game except geese and brant; provided, nonresident licensee may carry out of Province 12 birds killed by himself if tagged and carried open to view. Export of migratory birds prohibited during close season.

Miscellaneous: Use prohibited of automatic, pump, machine gun, rifle, or other gun loaded with bullets in hunting game birds.

QUEBEC.

Open seasons: [96]	*Dates inclusive.*
Bull moose (see exception), caribou	Sept. 20–Dec. 31.
Exception: In Pontiac and Temiscaming Counties	Sept. 10–Dec. 31.
Deer	Sept. 1–Nov. 30.
Hare	Oct. 15–Jan. 31.
Bear	Aug. 20–June 30.
Birch or swamp partridge	Sept. 1–Dec. 14.
White partridge or ptarmigan	Nov. 1–Jan. 31.
Duck, goose, brant, rail, coot, gallinule, woodcock, jacksnipe or Wilson snipe, black-breasted and golden plovers, yellowlegs	Sept. 1–Dec. 14.

No open season: Cow moose, young of deer, moose, and caribou, swans, wood duck, eider ducks, auks, bitterns, fulmars, gannet, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, terns, and all shore birds (except woodcock, Wilson snipe, black-breasted and golden plovers, and yellowlegs).

Hunting licenses: Nonresident: General, $25 (members of incorporated hunting clubs $10). Resident, $1 (not required of resident British subject hunting for own use); resident special, $5 (3 deer and 3 caribou additional to limit). Issued by Minister of Colonization.

Bag limits and possession: Two deer, 1 moose, 2 caribou a season; 2 caribou and 3 deer under special resident license. Twenty-five ducks, 15 geese, 15 brant, 25 in all of rails, coot, and gallinules, 10 woodcock, 25 Wilson snipe, and 15 in all of plovers and yellowlegs a day. Game lawfully killed may be possessed until 15 days after close of open season.

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[96] *Quebec:* By a Dominion order in council, it is unlawful to capture, take, injure, or molest migratory game, migratory insectivorous, or other migratory nongame bird, or to take, injure, destroy, or molest their nests or eggs within the following areas:

"A strip of land 10 feet in depth, along the cliff and the cliff itself on the north and east sides of Bonaventure Island in the County of Gaspe;

"The Bird Rocks and a 1-mile zone surrounding the same;

"Perce Rock and a 1-mile zone surrounding the same, except that where the mainland is distant less than 1 mile from Perce Rock, the shore of such mainland shall constitute the boundary of the zone."

Sale: Sale of birch or spruce partridge prohibited until October 1, 1925. Game lawfully taken may be sold from the third day of open season to and including the fifteenth day after expiration of open season, except the sale of migratory birds is prohibited during close season. Licensed hotels, restaurants, and clubs may serve game lawfully taken, except birch or spruce partridge.

Export: Export of moose, caribou, and deer, or parts thereof, prohibited except under permit issued from Minister of Colonization (fee not to exceed $5); also under tags attached to nonresident license not later than 15 days after close of season; export of migratory birds prohibited during close season.

SASKATCHEWAN.

Open seasons: [97] *Dates inclusive.*

Deer, moose (males only), caribou .... Nov. 15–Dec. 14.[98]
Prairie chicken (sharp-tailed or pinnated grouse) .... Oct. 15–Oct. 31.
Duck, goose, brant, rail, coot, gallinule, Wilson snipe or jacksnipe, black-breasted and golden plovers, yellowlegs .... Sept. 15–Dec. 31.

No open season: Antelope, buffalo, elk, and female of big game, other than caribou, and young of big game under one year of age.[99] Partridge (ruffed grouse), sage grouse, Canada or spruce grouse; swans, wood duck, bitterns, little brown, sandhill, and whooping cranes, grebes, gulls, herons, loons, terns, and all shorebirds (except Wilson or jacksnipe, black-breasted and golden plovers, and yellowlegs).

Hunting licenses: Nonresident: Big game, $25; birds, $15; domiciled in Canada, $5; issued by minister of agriculture. Resident: Big game, $5; birds, $1.25. Issued by minister or agent. Bird license not required of residents hunting on land outside city, town, village, or hamlet on which they are actually domiciled. No license issued to person under 16 without written consent of parent or guardian. Big-game hunters must wear white suit and cap. Hunting prohibited on inclosed lands without consent.

Bag limits and possession: One moose, 2 deer, 2 caribou, but not more than 2 in all a season; prairie chicken, 6 a day, 30 a season; 50 in all of ducks, geese, and brant a day, 250 a season; 25 in all of rail, coot, and gallinule, 25 Wilson snipe, and 15 in all of plovers and yellowlegs a day. Game birds may be kept in licensed storage from September 16 to March 1 and flesh of big game from December 1 to April 1 if tagged with number and kinds of game, name of depositor, and number of his hunting license.

Sale: Sale of all protected game prohibited.

Export: Export of all protected game prohibited; provided, minister of agriculture may grant permits to export for scientific purposes or propagation in public parks and zoological gardens 1 pair each species of big game and game birds upon payment of $5, or for propagation a specified number on application of another Province or State. Minister may issue permits to export deer (fee $2 per head) or other big game (fee $5 per head), hides of big game (fee $1 each), flesh of big game (fee $1 for each 20 pounds or less), birds (except grouse family) (fee $1 per dozen, limit 5 dozen per season). Nonresident licensee on leaving Province may take with him during open season personally under his license and permit big game and 100 game birds legally killed. Export of migratory birds prohibited during close season.

YUKON.

Open seasons: [1] *Dates inclusive.*

Deer, moose, caribou, sheep, goat (males only) .... Aug. 1–Mar. 1.
Partridge, prairie chicken, grouse, ptarmigan, pheasant .... Sept. 1–Mar. 15.
Duck, goose, brant, rail, coot, gallinule, Wilson snipe or jacksnipe, black-breasted and golden plovers, yellowlegs .... Sept. 1–Dec. 14.

No open season: Elk or wapiti, musk ox, bison or buffalo, and females of other big game; swans, eider ducks, cranes, grebes, gulls, jaegers, loons, terns, and all shorebirds (except Wilson snipe or jacksnipe, black-breasted and golden plovers, and yellowlegs).

Hunting licenses: Nonresident, $200. Resident, $25 (special license authorizing the killing of male moose and male caribou over 1 year of age at any time for food supplies in the Territory); licensee must make annual returns. Resident: Chief guide, $20; assistant guide, $10; camp helper, $5. Issued by commissioner or game guardian.

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[97] *Saskatchewan:* Lieutenant governor in council may extend close seasons over current year, within limits, on petition of six game guardians.

[98] Applies north of line between townships 34 and 35; south of said line no open season.

[99] Male moose having horns less than 6 inches in length deemed to be under one year of age.

[1] *Yukon:* Indians, explorers, surveyors, prospectors, miners, and travelers in need of food may take game during close season. Commissioner in council may alter seasons.

Bag limits: Six caribou, 6 deer, 2 moose, 2 sheep, 2 goats a season; 25 ducks, 15 geese, 15 brant, 25 in all of rail, coot, and gallinule, 10 woodcock, 25 Wilson snipe, and 15 in all of plovers and yellowlegs a day.

Sale: Deer, moose, caribou, sheep, and goats lawfully taken may be sold during the open season and 60 days thereafter. Male moose and male caribou over 1 year of age killed by a resident under special license may be sold at any time for food upon obtaining certificate of lawful killing from a game guardian. License (fee, $10) required to purchase and traffic in the flesh of moose or caribou. Licensee must make annual returns. Sale of migratory birds prohibited during close season.

Export: Export of migratory birds prohibited during close season. Upon affidavit of lawful killing, commissioner may issue permit to export game. Export of raw hide of moose or caribou prohibited except under permit. Trophies, including head, hide, and hoofs, of big game lawfully killed by nonresident may be exported under his license and certificate of game guardian.

Colony of Newfoundland.

Open seasons:	*Dates inclusive.*
Caribou (except in a special region near Grand Lake, no open season)	Aug. 1–Sept. 30. Oct. 21–Jan. 31.
Hare, rabbit	Sept. 20–Jan. 1.[2]
Ptarmigan, willow grouse or partridge, plovers, curlew, snipe, or "other wild or migratory birds (except wild geese and crows)"	Sept. 20–Jan. 1.

No open season: Elk, moose.

Hunting and fishing licenses: Nonresident: Caribou, $51; fish (salmon and sea trout), $10.50. Guide, nonresident, $50; resident, free.

Caribou licenses issued by game and inland fisheries board, stipendary magistrate, or justice of peace.

Unlicensed guides not to be employed. Guide shall not guide party of more than three sportsmen.

Bag limits: Three caribou (stags) a season by nonresident licensee; 2 stags, 1 doe by resident.

Sale: Caribou may be sold from August 1 to January 1; ptarmigan, willow grouse taken in open season may be sold until January 15; other birds may be sold during open season.

Export: Export for sale prohibited of caribou, partridge, willow or other grouse; provided, game and inland fisheries board may issue licenses to export caribou for breeding or scientific purposes. Licensee may export three stag caribou under hunting license and export permit (fee, 50 cents); resident may export antlers, head, or skin of caribou under export permit, but not, in either case, for sale.

DISPOSITION OF GAME RAISED IN CAPTIVITY.

Regulations adopted under the Federal migratory-bird treaty act, permitting the propagation and sale of migratory waterfowl,[3] pave the way for the upbuilding in this country of an industry from which many persons have been barred by lack of suitable legislation. It has been demonstrated that game animals and birds, especially certain species of migratory waterfowl, will yield satisfactory returns when propagated on farms and preserves. It is believed that the demand will far exceed the supply for a number of years, in view of the increased restrictions on the sale of native wild game and of the fact that migratory birds can no longer be sold on the market anywhere in the United States unless they have been reared in captivity in accordance with the law and regulations. The Department of Agriculture, acting in conjunction with State game officials, will aid so far as possible in establishing this industry, both in preparing drafts of suitable laws to be enacted by the various States and in assisting breeders to obtain eggs and breeding stock. The department is not and never has been in a position to furnish breeding stock or the eggs of any species of game bird for propagating purposes, contrary to frequent reports in the press, but it will assist legitimate enterprises by granting the necessary permits to propagate migratory waterfowl in captivity and to take birds or eggs for propagating purposes. Reasonable and proper regulations of Federal and State Governments will permit domesticated game to reach the market for consumption at all seasons and at the same time will prevent the infringement of laws to conserve the supply of native game.

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[2] *Newfoundland:* Hare or rabbit may also be taken with trap or snare until March 1.

[3] Waterfowl are the only migratory birds that are permitted to be raised in captivity, and permits therefor must be obtained from the Secretary of Agriculture, Washington, D. C., in accordance with the regulations. (See Regulations 8, p. 70.) For Canadian regulations on propagation of migratory birds, see Regulation 8D, p. 77.

Federal regulations: Under permit from the Secretary of Agriculture, Washington, D. C., and subject to the provisions of State laws relating thereto, migratory waterfowl may be possessed, sold, and transported at any time for propagation and the carcasses with heads and feet attached of propagated birds killed in any manner, except that they may be killed by shooting only during the open season for waterfowl in the State where killed, may be sold and transported at any time to any person for actual consumption, or to the keeper of a hotel, restaurant, or boarding house, retail dealer in meat or game, or a club, for sale or service to their patrons, who may possess such carcasses for actual consumption without a Federal permit; provided, that no migratory waterfowl killed by shooting shall be bought or sold unless each bird before attaining the age of four weeks shall have had removed from the web of one foot a portion thereof in the form of a "V" for identification purposes. (See Reg. 8, p. 70, for full details and requirements.)

About two-thirds of the States now have some special provision regulating possession, sale, or export of game raised in captivity. The following table giving a digest of the various State laws on the subject serves to show the lack of uniformity and the need of additional legislation to attain the results desired:

Arkansas: The commission may establish rules governing propagation of game in captivity and authorize the sale or export of such game under permit.

California: Game raised in captivity under breeder's license (fee, $2.50) may be sold at any time for breeding purposes or may be sold under license and regulations of commissioners for food when properly tagged (fee, 3 cents a tag). All domesticated game (except deer) must be killed otherwise than by shooting.

Colorado: Game furnished from a private park or lake of class A may be sold by hotels and restaurants at any time. Game taken from licensed private parks may be sold or shipped at any time if accompanied by an invoice.

Connecticut: Deer, pheasants, and wild fowl raised in licensed preserves (fee, $2) may be sold or transported at any time, when duly tagged, under regulations of commissioners of fisheries and game.

Delaware: Unlawful to kill, sell, or possess Hungarian partridge or pheasants except for scientific or propagating purposes.

District of Columbia: Hungarian partridge, English, ringneck, Mongolian, or Chinese pheasants raised in captivity may be sold at any time.

Georgia: Registered breeder may sell game for propagation.

Idaho: Permit of State warden required to take or keep waterfowl in captivity for decoy purposes.

Illinois: Game raised in captivity under a breeder's license (fee, $5) may be sold for propagation purposes, or may be killed, sold, and transported for food at any time.

Indiana: Birds and animals bred and reared in captivity may be killed, sold, or transported at any time under certificate of inspection (fee, $10) from the conservation commission.

Iowa: Game birds raised in captivity under license (fee, $2) may be sold.

Kansas: Game raised in capticity may be transported for scientific or propagating purposes under permit of warden and $1,000 bond.

Kentucky: Game birds and game animals bred in captivity under permit may be sold, transported, or otherwise disposed of at any time when duly tagged.

Louisiana: Game raised in captivity under $5 license may be sold alive for stocking or breeding purposes, and may be killed, transported, and sold for food at any time if tagged with metal tag. Traffic in birds killed by shooting prohibited.

Maine: Game raised in captivity under a $2 breeder's license may be killed, sold, or transported at any time under regulations of commissioners.

Maryland: Elk and imported and native deer raised in licensed preserve (fee, $5) may be sold, dead or alive, at any time. (In Allegany and Garrett Counties white-tailed deer native to the State must be branded three months prior to killing.) The propagation and killing of English or ringneck pheasants in captivity is permitted, except that hen pheasants may be killed only during the open season (Nov. 10 to Jan. 1) by means other than shooting. In Washington County game animals and birds reared in licensed preserves (fee, $10) may be sold for propagation only.

Massachusetts: Quail reared in captivity under permit may be exported. Game may be reared in captivity under license (no fee) and sold for propagation under regulations of commissioners; deer, elk, pheasants, quail, European or gray partridge, and wild fowl may be reared in captivity under license (no fee) and sold for food when properly tagged. Tag fee, 5 cents. Licensed dealers may sell such game.

Michigan: Deer, elk, pheasants, and wild ducks may be raised in captivity under $5 license and sold at any time for breeding or stocking purposes and the carcasses transported or sold for food when properly tagged (tags, 5 cents each). Ducks killed by shooting[4] (except under direct supervision of a deputy warden) may not be sold or disposed of. Licensed retail dealer, club, hotel, restaurant, etc., may sell portion of tagged game to patron or customer for actual consumption or use without additional license.

Minnesota: Game raised in captivity under license (fee, $1) may be sold alive at any time for propagating purposes, and may be killed, sold, and transported under regulations of commissioner. No fee required to raise game birds for domestic use or as pets. Under regulations of the commissioner, wild animals and the eggs of birds may be taken for breeding purposes.

Missouri: Deer, elk, and other protected game raised in captivity under license (fee, $5) may be transported and sold under regulations of the commissioner.

Montana: Game raised in licensed private preserve (fee, $5) may be killed, sold, or transported at any time. If nucleus stock is captured from wild animals in the State, no such animals nor their progeny shall be sold for a period of three years.

Nevada: Game raised in licensed preserve (fee, $10) may be sold or shipped at any time under invoice.

New Hampshire: Game raised in captivity under $2 license may be sold or transported at any time when properly tagged under regulations of commissioner.

New Jersey: Mallard, wood, and black ducks and Canada geese (when raised under Federal permit[4]), English and Mongolian pheasants, quail, ruffed grouse, deer, rabbits, and squirrels raised in licensed preserves (fee, $5) may be killed at any time, and if properly tagged (tag fee, 5 cents) may be sold for food or exported for sale. Live deer, on payment of $5 for each animal, and game birds possessed under a breeder's license may be exported for propagation.

New Mexico: Game raised in licensed preserve may be exported or sold at any time, under invoice, if the number of animals or birds in the park at the time the license is secured is not thereby reduced.

New York: Elk, white-tailed deer, European red deer, fallow deer, Japanese deer, roebuck, pheasants, Canada geese, Hutchins geese, mallard, and black ducks raised in captivity under license may be sold for breeding purposes and may be killed, sold, or exported at any time under license when properly tagged. Said ducks and geese may be killed by shooting during open season only, but ducks and geese[4] killed by shooting may not be sold, except under regulations of commission. Varying hares and cottontail rabbits bred in captivity under $5 license may be sold for food during close season, when properly tagged, under rules and regulations of the conservation department.

North Carolina: Several counties have laws in regard to game raised in captivity.

North Dakota: Board may issue permits to breed or domesticate game.

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[4] *Michigan, New Jersey, and New York:* See Federal Regulation, 8, p. 70.

Ohio: Ringneck, Mongolian, or Chinese pheasants and mallard and black ducks raised in captivity under a breeder's license (fee, $5), may be sold for propagation and may be killed and sold when duly tagged. No pheasant, mallard, or black duck raised in domestication shall be killed by shooting except during the open season, and no mallard or black duck killed by shooting shall be bought or sold unless it shall have had a well defined V shaped section removed from the web of one foot before it attains the age of four weeks. Packages must be labeled to show the number and kinds of birds contained therein, together with the name and address of the consignor.

Deer, squirrels, and rabbits may be possessed in inclosures as pets.

Oklahoma: Game raised under license (fee, $2) may be transported for propagation at any time, and for food, when properly tagged, during season prescribed by commissioner.

Oregon: Game birds and animals raised in captivity under permit (fee, $2) may be exported or sold at any time for propagating, restocking, or food purposes; carcasses must be properly tagged by State warden or deputy. Tag fee, 5 cents each. Written permit from State warden, showing kind of game and names and addresses of consignor and consignee, must be attached to each shipment.

Pennsylvania: Game breeder's certificate, fee $1, bond $500. Game raised in captivity may be sold alive or dead within the State.

Rhode Island: Game raised in captivity under permit may be sold if alive at any time for propagation, under regulations of commissioners.

South Carolina: Any birds or animals protected by law may be kept in possession for purposes of propagation or domestication.

South Dakota: Game raised in captivity may be exported or sold under written permission of State game warden.

Utah: Game raised in licensed private preserves (fee, $25) may be sold when duly tagged. Fifty birds and ten animals of each kind may be captured, under permit of commissioner, for propagating purposes.

Vermont: Game raised in licensed private preserves (fee, $2) may be exported at any time when duly marked and tagged, and may be sold for propagation at any time, or for food, under tag in accordance with regulations of commissioner.

Virginia: Game animals and birds raised under breeder's license (fee, $25) may be disposed of at any time for propagating or other purposes. Packages containing animals or birds transported for propagating purposes must be marked to show clearly the names of consignor and consignee and that they are being transported for propagating purposes. Carcasses of game animals or birds must be tagged (fees, smaller birds and animals, 2 cents; wild turkeys, 10 cents; deer, bear, or elk, 50 cents). Proprietor of hotel or restaurant or a dealer may sell under a $5 license to guests or patrons game raised in captivity. (No license required of keeper of hotel or restaurant or a dealer to sell, during open season, waterfowl and rabbits raised in captivity or other species of propagated game the sale of which is not prohibited.)

Holder of a game breeder's license, under permit and regulation of the commissioner, may trap wild animals or birds for breeding purposes, but the animals or birds so taken shall not be sold or otherwise disposed of.

Washington: Game and fur-bearing animals and wild birds may be raised in captivity under license (fee, $10) and sold and transported for food or propagating purposes when properly tagged. Keeper of hotel, restaurant, boarding house, or club, and retail dealer in meats, when duly licensed (fee, $5), may sell carcasses or parts thereof when properly tagged. Under proper permit from State game warden, animals and birds may be captured on State game preserves or imported from another State or country for propagating purposes.

West Virginia: The owner of elk kept in inclosure may kill them at any time, and may pursue and recapture, by killing or otherwise, elk which have escaped from his inclosure. Tame deer may be killed by the owner.

Wisconsin: Under permit and supervision of the commission wild animals may be taken and transported for propagation within the State.

Wyoming: Under permit (fee, $5) and supervision of the commission game animals may be taken for propagation, but animals so taken may not be killed, sold, or disposed of for 3 years. Natural increase may be sold or disposed of at any time.

LACEY ACT, REGULATING INTERSTATE COMMERCE IN GAME.

Federal laws affecting the shipment of game comprise statutes regulating interstate commerce in game and the importation of birds and mammals from foreign countries, as follows:

CRIMINAL CODE—ACT OF MARCH 4, 1909.

[35 Stat., 1137.]

SEC. 241. The importation into the United States, or any Territory or District thereof, of the mongoose, the so-called "flying foxes," or fruit bats, the English sparrow, the starling, and such other birds and animals as the Secretary of Agriculture may from time to time declare to be injurious to the interests of agriculture or horticulture, is hereby prohibited; and all such birds and animals shall, upon arrival at any port of the United States, be destroyed or returned at the expense of the owner. No person shall import into the United States or into any Territory or District thereof any foreign wild animal or bird, except under special permit from the Secretary of Agriculture: *Provided*, That nothing in this section shall restrict the importation of natural-history specimens for museums or scientific collections, or of certain cage birds, such as domesticated canaries, parrots, or such other birds as the Secretary of Agriculture may designate. The Secretary of the Treasury is hereby authorized to make regulations for carrying into effect the provisions of this section.

SEC. 242. It shall be unlawful for any person to deliver to any common carrier for transportation, or for any common carrier to transport from any State, Territory, or District of the United States to any other State, Territory, or District thereof, any foreign animals or birds the importation of which is prohibited, or the dead bodies or parts thereof of any wild animals or birds, where such animals or birds have been killed or shipped in violation of the laws of the State, Territory, or District in which the same were killed, or from which they were shipped: *Provided*, That nothing herein shall prevent the transportation of any dead birds or animals killed during the season when the same may be lawfully captured, and the export of which is not prohibited by law in the State, Territory, or District in which the same are captured or killed: *Provided further*, That nothing herein shall prevent the importation, transportation, or sale of birds or bird plumage manufactured from the feathers of barnyard fowls.

SEC. 243. All packages containing the dead bodies, or the plumage, or parts thereof, of game animals, or game or other wild birds, when shipped in interstate or foreign commerce, shall be plainly and clearly marked, so that the name and address of the shipper and the nature of the contents, may be readily ascertained on an inspection of the outside of such package.

SEC. 244. For each evasion or violation of any provision of the three sections last preceding, the shipper shall be fined not more than $200; the consignee knowingly receiving such articles so shipped and transported in violation of said sections shall be fined not more than $200; and the carrier knowingly carrying or transporting the same in violation of said sections shall be fined not more than $200.

SECTIONS 1 AND 5—ACT OF MAY 25, 1900.[5]

[31 Stat., 187–8.]

That the duties and powers of the Department of Agriculture are hereby enlarged so as to include the preservation, distribution, introduction, and restoration of game birds and other wild birds. The Secretary of Agriculture is hereby authorized to adopt such measures as may be necessary to carry out the purposes of this act and to purchase such game birds and other wild birds as may be required therefor, subject, however, to the laws of the various States and Territories. The object and purpose of this act is to aid in the restoration of such birds in those parts of the United States adapted thereto where the same have become scarce or extinct, and also to regulate the introduction of American or foreign birds or animals in localities where they have not heretofore existed.

The Secretary of Agriculture shall from time to time collect and publish useful information as to the propagation, uses, and preservation of such birds.

And the Secretary of Agriculture shall make and publish all needful rules and regulations for carrying out the purposes of this act, and shall expend for said purposes such sums as Congress may appropriate therefor.

SEC. 5. That all dead bodies, or parts thereof, of any foreign game animals, or game or song birds, the importation of which is prohibited, or the dead bodies, or parts thereof, of any wild game animals, or game or song birds transported into any State or Territory, or remaining therein for use, consumption, sale, or storage therein, shall upon arrival in such State or Territory be subject to the operation and effect of the laws of such State or Territory enacted in the exercise of its police powers, to the same extent and in the same manner as though such animals or birds had been produced in such State or Territory, and shall not be exempt therefrom by reason of being introduced therein in original packages or otherwise. This act shall not prevent the importation, transportation, or sale of birds or bird plumage manufactured from the feathers of barnyard fowl.

TARIFF ACT PROHIBITING IMPORTATION OF PLUMAGE.

ACT OF OCTOBER 3, 1913.

[38 Stat., 148.]

PAR. 347. Feathers and downs, on the skin or otherwise, crude or not dressed, colored, or otherwise advanced or manufactured in any manner, not specially provided for in this section, twenty per centum ad valorem; when dressed, colored, or otherwise advanced or manufactured in any manner, and not suitable for use as millinery ornaments, including quilts of down and manufactures of down, forty per centum ad valorem; artificial or ornamental feathers suitable for use as millinery ornaments, artificial and ornamental fruits, grains, leaves, flowers, and stems or parts thereof, of whatever material composed, not specially provided for in this section, sixty per centum ad valorem; boas, boutonnières, wreaths, and all articles not specially provided for in this section, composed wholly or in chief value of any of the feathers, flowers, leaves, or other material herein mentioned, sixty per centum ad valorem: *Provided*, That the importation of aigrettes, egret plumes, or so-called osprey plumes, and the feathers, quills, heads, wings, tails, skins, or parts of skins, of wild birds, either raw or manufactured and not for scientific or educational purposes, is hereby prohibited; but this provision shall not apply to the feathers or plumes of ostriches or to the feathers or plumes of domestic fowls of any kind.

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[5] Secs. 2, 3, and 4 superseded by secs. 241–244 of the Criminal Code, act of Mar. 4, 1909 (35 Stat., 1137).

LAW PROTECTING BIRDS AND THEIR EGGS ON FEDERAL BIRD RESERVATIONS.

ACT OF MARCH 4, 1909.

[35 Stat., 1104.]

SEC. 84. Whoever shall hunt, trap, capture, willfully disturb, or kill any bird of any kind whatever, or take the eggs of any such bird, on any lands of the United States which have been set apart or reserved as breeding grounds for birds, by any law, proclamation, or Executive order, except under such rules and regulations as the Secretary of Agriculture may, from time to time, prescribe, shall be fined not more than $500, or imprisoned not more than six months, or both.

HUNTING ON NATIONAL FORESTS.

Regulation T–7, effective October 1, 1919, of the Regulations of the Forest Service Relative to National Forests, provides as follows:

The following acts are prohibited on lands of the United States within National Forests:

The going or being upon any such land, or in or on the waters thereof, with intent to hunt, catch, trap, willfully disturb or kill any kind of game animal, game or nongame bird, or fish, or to take the eggs of any such bird, in violation of the laws of the State in which such land or waters are situated.

Regulation G–30 authorizes all forest officers to enforce the above regulation and also to cooperate with State or Territorial officials in the enforcement of local laws for the protection of birds, fish, and game.

CONVENTION BETWEEN THE UNITED STATES AND GREAT BRITAIN FOR THE PROTECTION OF MIGRATORY BIRDS IN THE UNITED STATES AND CANADA.[1]

[39 Stat., 1702.]

BY THE PRESIDENT OF THE UNITED STATES OF AMERICA.

A PROCLAMATION.

Whereas a Convention between the United States of America and the United Kingdom of Great Britain and Ireland for the protection of migratory birds in the United States and Canada was concluded and signed by their respective plenipotentiaries at Washington, on the sixteenth day of August, one thousand nine hundred and sixteen, the original of which Convention is word for word as follows:

Whereas, Many species of birds in the course of their annual migrations traverse certain parts of the United States and the Dominion of Canada; and

Whereas, Many of these species are of great value as a source of food or in destroying insects which are injurious to forests and forage plants on the public domain, as well as to agricultural crops, in both the United States and Canada, but are nevertheless in danger of extermination through lack of adequate protection during the nesting season or while on their way to and from their breeding grounds;

The United States of America and His Majesty the King of the United Kingdom of Great Britain and Ireland and of the British Dominions beyond the Seas, Emperor of India, being desirous of saving from indiscriminate slaughter and of insuring the preservation of such migratory birds as are either useful to man or are harmless, have resolved to adopt some uniform system of protection which shall effectively accomplish such objects and to the end of concluding a convention for this purpose have appointed as their respective Plenipotentiaries:

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[1] Signed at Washington August 16, 1916; ratification advised by the Senate August 29, ratified by the President September 1, and by Great Britain October 20; ratifications exchanged December 7; proclaimed December 8, 1916. Constitutionality of the treaty and act sustained by the United States Supreme Court in decision rendered April 19, 1920, in case of State of Missouri *v.* Ray P. Holland.

Canada, by an act of Parliament approved August 29, 1917, gave full effect to this convention, and promulgated regulations thereunder May 11, 1918. Validity of act of Dominion Parliament upheld by Supreme Court of Prince Edward Island in decision (Michaelmas term, 1920) rendered in case of The King *v.* Russell C. Clark.

The President of the United States of America, Robert Lansing, Secretary of State of the United States; and

His Britannic Majesty, the Right Honorable Sir Cecil Arthur Spring Rice, G. C. V. O., K. C. M. G., etc., His Majesty's Ambassador Extraordinary and Plenipotentiary at Washington;

Who, after having communicated to each other their respective full powers which were found to be in due and proper form, have agreed to and adopted the following articles:

ARTICLE I.

The High Contracting Powers declare that the migratory birds included in the terms of this Convention shall be as follows:

1. Migratory Game Birds:

(*a*) Anatidae or waterfowl, including brant, wild ducks, geese, and swans.

(*b*) Gruidae or cranes, including little brown, sandhill, and whooping cranes.

(*c*) Rallidae or rails, including coots, gallinules and sora and other rails.

(*d*) Limicolae or shorebirds, including avocets, curlew, dowitchers, godwits, knots, oyster catchers, phalaropes, plovers, sandpipers, snipe, stilts, surf birds, turnstones, willet, woodcock and yellowlegs.

(*e*) Columbidae or pigeons, including doves and wild pigeons.

2. Migratory Insectivorous Birds: Bobolinks, catbirds, chickadees, cuckoos, flickers, flycatchers, grosbeaks, humming birds, kinglets, martins, meadowlarks, nighthawks or bull bats, nut-hatches, orioles, robins, shrikes, swallows, swifts, tanagers, titmice, thrushes, vireos, warblers, wax-wings, whippoorwills, woodpeckers and wrens, and all other perching birds which feed entirely or chiefly on insects.

3. Other Migratory Nongame Birds: Auks, auklets, bitterns, fulmars, gannets, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, and terns.

ARTICLE II.

The High Contracting Powers agree that, as an effective means of preserving migratory birds there shall be established the following close seasons during which no hunting shall be done except for scientific or propagating purposes under permits issued by proper authorities.

1. The close season on migratory game birds shall be between March 10 and September 1, except that the close season on the Limicolae or shorebirds in the Maritime Provinces of Canada and in those States of the United States bordering on the Atlantic Ocean which are situated wholly or in part north of Chesapeake Bay shall be between February 1 and August 15, and that Indians may take at any time scoters for food but not for sale. The season for hunting shall be further restricted to such period not exceeding three and one-half months as the High Contracting Powers may severally deem appropriate and define by law or regulation.

2. The close season on migratory insectivorous birds shall continue throughout the year.

3. The close season on other migratory nongame birds shall continue throughout the year, except that Eskimos and Indians may take at any season auks, auklets, guillemots, murres and puffins, and their eggs, for food and their skins for clothing, but the birds and eggs so taken shall not be sold or offered for sale.

ARTICLE III.

The High Contracting Powers agree that during the period of ten years next following the going into effect of this Convention there shall be a continuous close season on the following migratory game birds, to wit:—

Band-tailed pigeons, little brown, sandhill and whooping cranes, swans, curlew and all shorebirds (except the black-breasted and golden plover, Wilson or jack snipe, woodcock, and the greater and lesser yellowlegs); provided that during such ten years the close seasons on cranes, swans and curlew in the Province of British Columbia shall be made by the proper authorities of that Province within the general dates and limitations elsewhere prescribed in this Convention for the respective groups to which these birds belong.

ARTICLE IV.

The High Contracting Powers agree that special protection shall be given the wood duck and the eider duck either (1) by a close season extending over a period of at least five years, or (2) by the establishment of refuges, or (3) by such other regulations as may be deemed appropriate.

ARTICLE V.

The taking of nests or eggs of migratory game or insectivorous or nongame birds shall be prohibited, except for scientific or propagating purposes under such laws or regulations as the High Contracting Powers may severally deem appropriate.

ARTICLE VI.

The High Contracting Powers agree that the shipment or export of migratory birds or their eggs from any State or Province, during the continuance of the close season in such State or Province, shall be prohibited except for scientific or propagating purposes, and the international traffic in any birds or eggs at such time captured, killed, taken, or shipped at any time contrary to the laws of the State or Province in which the same were captured, killed, taken, or shipped shall be likewise prohibited. Every package containing migratory birds or any parts thereof or any eggs of migratory birds transported, or offered for transportation from the United States into the Dominion of Canada or from the Dominion of Canada into the United States, shall have the name and address of the shipper and an accurate statement of the contents clearly marked on the outside of such package.

ARTICLE VII.

Permits to kill any of the above-named birds which, under extraordinary conditions, may become seriously injurious to the agricultural or other interests in any particular community, may be issued by the proper authorities of the High Contracting Powers under suitable regulations prescribed therefor by them respectively, but such permits shall lapse, or may be canceled, at any time when, in the opinion of said authorities, the particular exigency has passed, and no birds killed under this article shall be shipped, sold, or offered for sale.

ARTICLE VIII.

The High Contracting Powers agree themselves to take, or propose to their respective appropriate law-making bodies, the necessary measures for insuring the execution of the present Convention.

ARTICLE IX.

The present Convention shall be ratified by the President of the United States of America, by and with the advice and consent of the Senate thereof, and by His Britannic Majesty. The ratifications shall be exchanged at Washington as soon as possible and the Convention shall take effect on the date of the exchange of the ratifications. It shall remain in force for fifteen years and in the event of neither of the High Contracting Powers having given notification, twelve months before the expiration of said period of fifteen years, of its intention of terminating its operation, the Convention shall continue to remain in force for one year and so on from year to year.

In faith whereof, the respective Plenipotentiaries have signed the present Convention in duplicate and have hereunto affixed their seals.

Done at Washington this sixteenth day of August, one thousand nine hundred and sixteen.

[SEAL.] ROBERT LANSING.
[SEAL.] CECIL SPRING RICE.

And whereas the said Convention has been duly ratified on both parts, and the ratifications of the two Governments were exchanged in the City of Washington, on the seventh day of December, one thousand nine hundred and sixteen;

Now, therefore, be it known that I, WOODROW WILSON, President of the United States of America, have caused the said Convention to be made public, to the end that the same and every article and clause thereof may be observed and fulfilled with good faith by the United States and the citizens thereof.

In testimony whereof, I have hereunto set my hand and caused the seal of the United States to be affixed.

Done at the City of Washington this eighth day of December in the year of our Lord one thousand nine hundred and sixteen, and of the Independence of the United States of America the one hundred and forty-first.

[SEAL.]

WOODROW WILSON.

By the President:
ROBERT LANSING,
Secretary of State.

MIGRATORY BIRD TREATY ACT.[3]

[Approved July 3, 1918. 40 Stat., 755.]

AN ACT To give effect to the convention between the United States and Great Britain for the protection of migratory birds concluded at Washington, August sixteenth, nineteen hundred and sixteen, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act shall be known by the short title of the "Migratory Bird Treaty Act.".

SEC. 2. That unless and except as permitted by regulations made as hereinafter provided, it shall be unlawful to hunt, take, capture, kill, attempt to take, capture or kill, possess, offer for sale, sell, offer to purchase, purchase, deliver for shipment, ship, cause to be shipped, deliver for transportation, transport, cause to be transported, carry or cause to be carried by any means whatever, receive for shipment, transportation or carriage, or export, at any time or in any manner, any migratory bird, included in the terms of the convention between the United States and Great Britain for the protection of migratory birds concluded August sixteen, nineteen hundred and sixteen, or any part, nest, or egg of any such bird.

SEC. 3. That subject to the provisions and in order to carry out the purposes of the convention, the Secretary of Agriculture is authorized and directed, from time to time, having due regard to the zones of temperature and to the distribution, abundance, economic value, breeding habits, and times and lines of migratory flight of such birds, to determine when, to what extent, if at all, and by what means, it is compatible with the terms of the convention to allow hunting, taking, capture, killing, possession, sale, purchase, shipment, transportation, carriage, or export of any such bird, or any part, nest, or egg thereof, and to adopt suitable regulations permitting and governing the same, in accordance with such determinations, which regulations shall become effective when approved by the President.

SEC. 4. That it shall be unlawful to ship, transport, or carry, by any means whatever, from one State, Territory, or District to or through another State, Territory, or District, or to or through a foreign country, any bird, or any part, nest, or egg thereof, captured, killed, taken, shipped, transported, or carried at any time contrary to the laws of the State, Territory, or District in which it was captured, killed, or taken, or from which it was shipped, transported, or carried. It shall be unlawful to import any bird, or any part, nest, or egg thereof, captured, killed, taken, shipped, transported, or carried contrary to the laws of any Province of the Dominion of Canada in which the same was captured, killed, or taken, or from which it was shipped, transported, or carried.

SEC. 5. That any employee of the Department of Agriculture authorized by the Secretary of Agriculture to enforce the provisions of this Act shall have power, without warrant, to arrest any person committing a violation of this Act in his presence or view and to take such person immediately for examination or trial before an officer or court of competent jurisdiction; shall have power to execute any warrant or other process issued by an officer or court of competent jurisdiction for the enforcement of the provisions of this Act; and shall have authority, with a search warrant, to search any place. The several judges of the courts established under the laws of the United States, and United States commissioners may, within their respective jurisdictions, upon proper oath or affirmation showing probable cause, issue warrants in all such cases. All birds, or parts, nests, or eggs thereof, captured, killed, taken, shipped, transported, carried, or possessed contrary to the provisions of this Act or of any regulations made pursuant thereto shall, when found, be seized by any such employee, or by any marshal or deputy marshal, and, upon conviction of the offender or upon judgment of a court of the United States that the same were captured, killed, taken, shipped, transported, carried, or possessed contrary to the provisions of this Act or of any regulation made pursuant thereto, shall be forfeited to the United States and disposed of as directed by the court having jurisdiction.

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[3] Constitutionality of act sustained by Supreme Court in decision rendered April 19, 1920, in case of State of Missouri *v.* Ray P. Holland.

Sec. 6. That any person, association, partnership, or corporation who shall violate any of the provisions of said convention or of this Act, or who shall violate or fail to comply with any regulation made pursuant to this Act, shall be deemed guilty of misdemeanor and upon conviction thereof shall be fined not more than $500 or be imprisoned not more than six months, or both.

Sec. 7. That nothing in this Act shall be construed to prevent the several States and Territories from making or enforcing laws or regulations not inconsistent with the provisions of said convention or of this Act, or from making or enforcing laws or regulations which shall give further protection to migratory birds, their nests, and eggs, if such laws or regulations do not extend the open seasons for such birds beyond the dates approved by the President in accordance with section three of this Act.

Sec. 8. That until the adoption and approval, pursuant to section three of this Act, of regulations dealing with migratory birds and their nests and eggs, such migratory birds and their nests and eggs as are intended and used exclusively for scientific or propagating purposes may be taken, captured, killed, possessed, sold, purchased, shipped, and transported for such scientific or propagating purposes if and to the extent not in conflict with the laws of the State, Territory, or District in which they are taken, captured, killed, possessed, sold, or purchased, or in or from which they are shipped or transported if the packages containing the dead bodies or the nests or eggs of such birds when shipped and transported shall be marked on the outside thereof so as accurately and clearly to show the name and address of the shipper and the contents of the package.

Sec. 9. That the unexpended balances of any sums appropriated by the agricultural appropriation Acts for the fiscal years nineteen hundred and seventeen and nineteen hundred and eighteen, for enforcing the provisions of the Act approved March fourth, nineteen hundred and thirteen, relating to the protection of migratory game and insectivorous birds, are hereby reappropriated and made available until expended for the expenses of carrying into effect the provisions of this Act and regulations made pursuant thereto, including the payment of such rent, and the employment of such persons and means, as the Secretary of Agriculture may deem necessary, in the District of Columbia and elsewhere, cooperation with local authorities in the protection of migratory birds, and necessary investigations connected therewith: *Provided*, That no person who is subject to the draft for service in the Army or Navy shall be exempted or excused from such service by reason of his employment under this Act.

Sec. 10. That if any clause, sentence, paragraph, or part of this Act shall, for any reason, be adjudged by any court of competent jurisdiction to be invalid, such judgment shall not affect, impair, or invalidate the remainder thereof, but shall be confined in its operation to the clause, sentence, paragraph, or part thereof directly involved in the controversy in which such judgment shall have been rendered.

Sec. 11. That all Acts or parts of Acts inconsistent with the provisions of this Act are hereby repealed.

SEC. 12. Nothing in this Act shall be construed to prevent the breeding of migratory game birds on farms and preserves and the sale of birds so bred under proper regulation for the purpose of increasing the food supply.

SEC. 13. That this Act shall become effective immediately upon its passage and approval.

MIGRATORY-BIRD TREATY ACT REGULATIONS.

[As approved and promulgated by the President, July 31, 1918, and amended October 25, 1918, July 28, 1919, July 9, 1920, March 3, 1921, and May 17, 1921.]

REGULATION 1.—DEFINITIONS OF MIGRATORY BIRDS.

Migratory birds, included in the terms of the convention between the United States and Great Britain for the protection of migratory birds, concluded August 16, 1916, are as follows:

1. *Migratory game birds:*

(*a*) Anatidae, or waterfowl, including brant, wild ducks, geese, and swans.

(*b*) Gruidae, or cranes, including little brown, sandhill, and whooping cranes.

(*c*) Rallidae, or rails, including coot, gallinules, and sora and other rails.

(*d*) Limicolae, or shorebirds, including avocets, curlews, dowitchers, godwits, knots, oyster catchers, phalaropes, plovers, sandpipers, snipe, stilts, surf birds, turnstones, willet, woodcock, and yellowlegs.

(*e*) Columbidae, or pigeons, including doves and wild pigeons.

2. *Migratory insectivorous birds:* Cuckoos; flickers and other woodpeckers; nighthawks or bull-bats and whip-poor-wills; swifts; hummingbirds; flycatchers; bobolinks, meadowlarks, and orioles; grosbeaks; tanagers; martins and other swallows; waxwings; shrikes; vireos; warblers; pipits; catbirds and brown thrashers; wrens; brown creepers; nuthatches; chickadees and titmice; kinglets and gnat catchers; robins and other thrushes; and all other perching birds which feed entirely or chiefly on insects.

3. *Other migratory nongame birds:* Auks, auklets, bitterns, fulmars, gannets, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, and terns.

[As amended July 9, 1920.]

REGULATION 2.—DEFINITIONS OF TERMS.

For the purposes of these regulations the following terms shall be construed, respectively, to mean—

Secretary.—The Secretary of Agriculture of the United States.

Person.—The plural or the singular, as the case demands, including individuals, associations, partnerships, and corporations, unless the context otherwise requires.

Take.—The pursuit, hunting, capture, or killing of migratory birds in the manner and by the means specifically permitted.

Open season.—The time during which migratory birds may be taken.

Transport.—Shipping, transporting, carrying, exporting, receiving or delivering for shipment, transportation, carriage, or export.

REGULATION 3.—MEANS BY WHICH MIGRATORY GAME BIRDS MAY BE TAKEN.

The migratory game birds specified in Regulation 4 hereof may be taken during the open season with a gun only, not larger than No. 10 gauge, fired from the shoulder, except as specifically permitted by Regulations 7, 8, 9, and 10 hereof; they may be taken during the open season from the land and water, with the aid of a dog, the use of decoys, and from a blind or floating device (other than an airplane, powerboat, sailboat, any boat under sail, or any floating device towed by powerboat or sailboat).

[As amended July 28, 1919, March 3, 1921, and May 17, 1921.]

REGULATION 4.—OPEN SEASONS ON AND POSSESSION OF CERTAIN MIGRATORY GAME BIRDS.

For the purpose of this regulation, each period of time herein prescribed as an open season shall be construed to include the first and last days thereof.

Waterfowl (except wood duck, eider ducks, and swans), rails, coot, gallinules, black-bellied and golden plovers, greater and lesser yellowlegs, woodcock, Wilson snipe or jacksnipe, and mourning doves may be taken each day from half an hour before sunrise to sunset during the open seasons prescribed therefor in this regulation, by the means and in the numbers permitted by Regulations 3 and 5 hereof, respectively, and when so taken, may be possessed any day in any State, Territory, or District during the period constituting the open season where killed and for an additional period of 10 days next succeeding said open season, but no such birds shall be possessed in a State, Territory, or District at a time when such State, Territory, or District prohibits the possession thereof.

Waterfowl (except wood duck, eider ducks, and swans), coot, gallinules, and Wilson snipe or jacksnipe.—The open seasons for waterfowl (except wood duck, eider ducks, and swans), coot, gallinules, and Wilson snipe or jacksnipe shall be as follows:

In Maine, New Hampshire, Vermont, Massachusetts, New York (except Long Island), Pennsylvania, Ohio, West Virginia, Kentucky, Indiana, Michigan, Wisconsin, Illinois, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas, Colorado, Wyoming, Montana, Idaho, Nevada, and that portion of Oregon and Washington lying east of the summit of the Cascade Mountains the open season shall be from September 16 to December 31;

In Rhode Island, Connecticut, Utah, California, and that portion of Oregon and Washington lying west of the summit of the Cascade Mountains the open season shall be from October 1 to January 15;

In that portion of New York known as Long Island, and in New Jersey, Delaware, Oklahoma, Texas, New Mexico, and Arizona the open season shall be from October 16 to January 31;

In Maryland, the District of Columbia, Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, Arkansas, and Louisiana the open season shall be from November 1 to January 31; and

In Alaska the open season shall be from September 1 to December 15.

Rails (except coot and gallinules).—The open season for sora and other rails (except coot and gallinules) shall be from September 1 to November 30, except as follows:

In Louisiana the open season shall be from November 1 to January 31.

Black-bellied and golden plovers and greater and lesser yellowlegs.—The open seasons for black-bellied and golden plovers and greater and lesser yellowlegs shall be as follows:

In Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Delaware, Maryland, and Virginia the open season shall be from August 16 to November 30;

In the District of Columbia, North Carolina, South Carolina, Tennessee, Arkansas, Oklahoma, Texas, New Mexico, Arizona, California, and Alaska the open season shall be from September 1 to December 15;

In Vermont, Pennsylvania, Ohio, West Virginia, Kentucky, Indiana, Michigan, Wisconsin, Illinois, Missouri, Iowa, Minnesota, North Dakota, South Dakota, Nebraska, Kansas, Colorado, Wyoming, Montana, Idaho, Nevada, and that portion of Oregon and Washington lying east of the summit of the Cascade Mountains the open season shall be from September 16 to December 31;

In Utah and in that portion of Oregon and Washington lying west of the summit of the Cascade Mountains the open season shall be from October 1 to January 15; and

In Georgia, Florida, Alabama, Mississippi, and Louisiana the open season shall be from November 1 to January 31.

Woodcock.—The open season for woodcock shall be as follows:

In Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Ohio, West Virginia, Kentucky, Indiana, Michigan, Wisconsin, Illinois, Missouri, Iowa, Minnesota, North Dakota, South Dakota, Nebraska, and Kansas the open season shall be from October 1 to November 30; and

In Delaware, Maryland, the District of Columbia, Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, Arkansas, Louisiana, Texas, and Oklahoma the open season shall be from November 1 to December 31.

Doves.—The open seasons for mourning doves shall be as follows:

In Delaware, Maryland, Virginia, Tennessee, Kentucky, Ohio, Indiana, Illinois, Minnesota, Nebraska, Kansas, Missouri, Arkansas, Oklahoma, Texas, New Mexico, Colorado, Utah, Arizona, California, Nevada, Idaho, and Oregon the open season shall be from September 1 to December 15; and

In North Carolina, South Carolina, Georgia, Florida, Alabama, Louisiana, and Mississippi the open season shall be from October 16 to January 31.

[As amended October 25, 1918, July 28, 1919, July 9, 1920, and May 17, 1921.]

REGULATION 5.—BAG LIMITS ON CERTAIN MIGRATORY GAME BIRDS.

A person may take in any one day during the open seasons prescribed therefor in Regulation 4 not to exceed the following numbers of migratory game birds, which numbers shall include all birds taken by any other person who for hire accompanies or assists him in taking migratory birds:

Ducks (except wood duck and eider ducks).—Twenty-five in the aggregate of all kinds.

Geese.—Eight in the aggregate of all kinds.

Brant.—Eight.

Rails, coot, and gallinules (except sora).—Twenty-five in the aggregate of all kinds.

Sora.—Fifty.

Black-bellied and golden plovers and greater and lesser yellowlegs.—Fifteen in the aggregate of all kinds.

Wilson snipe, or jacksnipe.—Twenty-five.

Woodcock.—Six.

Doves (mourning).—Twenty-five.

[As amended October 25, 1918, July 28, 1919, and March 3, 1921.]

REGULATION 6.—SHIPMENT, TRANSPORTATION, AND POSSESSION OF CERTAIN MIGRATORY GAME BIRDS.

Waterfowl (except wood duck, eider ducks, and swans), rails, coot, gallinules, black-bellied and golden plovers, greater and lesser yellowlegs, woodcock, Wilson snipe or jacksnipe, and mourning doves and parts thereof legally taken may be transported in or out of the State where taken during the respective open seasons in that State, and may be imported from Canada during the open season in the Province where taken, in any manner, but not more than the number thereof that may be taken in two days by one person under these regulations shall be transported by one person in one calendar week out of the State where taken; any such migratory game birds or parts thereof in transit during the open season may continue in transit such additional time immediately succeeding such open season, not to exceed five days, necessary to deliver the same to their destination, and may be possessed in any State, Territory, or District during the period constituting the open season where killed, and for an additional period of ten days next succeeding said open season; and any package in which migratory game birds or parts thereof are transported shall have the name and address of the shipper and of the consignee and an accurate statement of the numbers and kinds of birds contained therein clearly and conspicuously marked on the outside thereof; but no such birds shall be transported from any State, Territory, or District to or through another State, Territory, or District, or to or through a Province of the Dominion of Canada contrary to the laws of the State, Territory, or District, or Province of the Dominion of Canada in which they were taken or from which they are transported; nor shall any such birds be transported into any State, Territory, or District from another State, Territory, or District, or from any State, Territory, or District into any Province of the Dominion of Canada at a time when such State, Territory, or District, or Province of the Dominion of Canada prohibits the possession or transportation thereof.

[As amended October 25, 1918, and July 9, 1920.]

REGULATION 7.—TAKING OF CERTAIN MIGRATORY NONGAME BIRDS BY ESKIMOS AND INDIANS IN ALASKA.

In Alaska Eskimos and Indians may take for the use of themselves and their immediate families, in any manner and at any time, and possess and transport auks, auklets, guillemots, murres, and puffins and their eggs for food, and their skins for clothing.

REGULATION 8.—PERMITS TO PROPAGATE AND SELL MIGRATORY WATERFOWL.

1. A person may take in any manner and at any time migratory waterfowl and their eggs for propagating purposes when authorized by a permit issued by the Secretary. Waterfowl and their eggs so taken may be possessed by the permittee and may be sold and transported by him for propagating purposes to any person holding a permit issued by the Secretary in accordance with the provisions of this regulation.

2. A person authorized by a permit issued by the Secretary may possess, buy, sell, and transport migratory waterfowl and their increase and eggs in any manner and at any time for propagating purposes; and migratory waterfowl, except the birds taken under paragraph 1 of this regulation, so possessed may be killed by him at any time, in any manner, except that they may be killed by shooting only during the open season for waterfowl in the State where killed, and the carcasses, with heads and feet attached thereto, of the birds so killed may be sold and transported by him in any manner and at any time to any person for actual consumption, or to the keeper of a hotel, restaurant, or boarding house, retail dealer in meat or game, or a club, for sale or service to their patrons, who may possess such carcasses for actual consumption without a permit, but no migratory waterfowl killed by shooting shall be bought or sold unless each bird before attaining the age of four weeks shall have had removed from the web of one foot a portion thereof in the form of a "V" large enough to make a permanent well-defined mark, which shall be sufficient to identify it as a bird raised in domestication under a permit.

3. Any package in which such waterfowl or parts thereof or their eggs are transported shall have plainly and conspicuously marked on the outside thereof the name and address of the permittee, the number of his permit, the name and address of the consignee, and an accurate statement of the number and kinds of birds or eggs contained therein.

4. Applications for permits must be addressed to the Secretary of Agriculture, Washington, D. C., and must contain the following information: Name and address of applicant; place where the business is to be carried on; number of acres of land used in the business and whether owned or leased by the applicant; number of each species of waterfowl in possession of applicant; names of species and number of birds or eggs of each species if permission is asked to take waterfowl or their eggs; and the particular locality where it is desired to take such waterfowl or eggs.

5. A person granted a permit under this regulation shall keep books and records which shall correctly set forth the total number of each species of waterfowl and their eggs possessed on the date of application for the permit and on the first day of January next following; also for the calendar year for which permit was issued the total number of each species reared and killed, number of each species and their eggs sold and transported, manner in which such waterfowl and eggs were transported, name and address of each person from or to whom waterfowl and eggs were purchased or sold, together with number and species and whether sold alive or dead; and the date of each transaction. A written report correctly setting forth this information shall be furnished the Secretary during the month of January next following the issuance of the permit.

6. A permittee shall at all reasonable hours allow any authorized employee of the United States Department of Agriculture to enter and inspect the premises where operations are being carried on under this regulation and to inspect the books and records of such permittee relating thereto.

7. Permits issued under this regulation shall be valid only during the calendar year of issue, shall not be transferable, and may be revoked by the Secretary, if the permittee violates any of the provisions of the Migratory Bird Treaty Act or of the regulations thereunder.

8. A person engaged in the propagation of migratory waterfowl on the date on which these regulations become effective will be allowed until September 30, 1918, to apply for the permit required by this regulation, but he shall not take any migratory waterfowl without a permit.

[As amended October 25, 1918, and July 9, 1920.]

REGULATION 9.—PERMITS TO COLLECT MIGRATORY BIRDS FOR SCIENTIFIC PURPOSES.

A person may take in any manner and at any time migratory birds and their nests and eggs for scientific purposes when authorized by a permit issued by the Secretary, which permit shall be carried on his person when he is collecting specimens thereunder and shall be exhibited to any person requesting to see the same.

Application for a permit must be addressed to the Secretary of Agriculture, Washington, D. C., and must contain the following information: Name and address of applicant, his age, and name of State, Territory, or District in which specimens are proposed to be taken and the purpose for which they are intended. Each application shall be accompanied by certificates from two well-known ornithologists that the applicant is a fit person to be intrusted with a permit.

The permit may limit the number and species of birds, birds' nests or eggs that may be collected thereunder and may authorize the holder thereof to possess, buy, sell, exchange, and transport in any manner and at any time migratory birds, parts thereof, and their nests and eggs for scientific purposes; or it may limit the holder to one or more of these privileges. Public museums, zoological parks and societies, and public scientific and educational institutions may possess, buy, sell, exchange, and transport in any manner and at any time migratory birds and parts thereof, and their nests and eggs for scientific purposes without a permit, but no specimens shall be taken without a permit. The plumage and skins of migratory game birds legally taken may be possessed and transported by a person without a permit.

A taxidermist when authorized by a permit issued by the Secretary may possess, buy, sell, exchange, and transport in any manner and at any time migratory birds and parts thereof legally taken, or he may be limited to one or more of these privileges.

Each permit shall expire on the thirty-first day of December succeeding its issuance unless otherwise specified therein, shall not be transferable, and shall be revocable at the discretion of the Secretary. A person holding a permit shall report to the Secretary on or before January 10 following its expiration the number of skins, nests, or eggs of each species collected, bought, sold, exchanged, or transported.

Every package in which migratory birds or their nests or eggs are transported shall have clearly and conspicuously marked on the outside thereof the name and address of the sender, the number of the permit in every case when a permit is required, the name and address of the consignee, a statement that it contains specimens of birds, their nests, or eggs for scientific purposes, and, whenever such a package is transported or offered for transportation from the Dominion of Canada into the United States or from the United States into the Dominion of Canada, an accurate statement of the contents.

[As amended October 25, 1918, and March 3, 1921.]

REGULATION 10.—PERMITS TO KILL MIGRATORY BIRDS INJURIOUS TO PROPERTY.

When information is furnished the Secretary that any species of migratory bird has become, under extraordinary conditions, seriously injurious to agriculture or other interests in any particular community, an investigation will be made to detemine the nature and extent of the injury, whether the birds alleged to be doing the damage should be killed, and, if so, during what times and by what means. Upon his determination an appropriate order will be made.

REGULATION 11.—STATE LAWS FOR THE PROTECTION OF MIGRATORY BIRDS.

Nothing in these regulations shall be construed to permit the taking, possession, sale, purchase, or transportation of migratory birds, their nests, and eggs contrary to the laws and regulations of any State, Territory, or District made for the purpose of giving further protection to migratory birds, their nests, and eggs when such laws and regulations are not inconsistent with the convention between the United States and Great Britain for the protection of migratory birds concluded August 16, 1916, or the migratory bird treaty act and do not extend the open seasons for such birds beyond the dates prescribed by these regulations.

[Added by proclamation of October 25, 1918, as amended July 9, 1920.]

ORDER.

PERMITTING THE KILLING OF BOBOLINKS, COMMONLY KNOWN AS REEDBIRDS OR RICE BIRDS, WHICH HAVE BECOME SERIOUSLY INJURIOUS TO AGRICULTURAL INTERESTS.

[Issued January 17, 1919.]

Information having been furnished the Secretary of Agriculture that bobolinks, commonly known as reedbirds or rice birds, have become seriously injurious to the rice crops of North Carolina, South Carolina, Georgia, and Florida, and an investigation having been duly and regularly made pursuant to law, and it having been determined by the Secretary of Agriculture that said birds have become, under extraordinary conditions, seriously injurious to the rice crops in said States and that the injuries so inflicted by them can not adequately be controlled in the communities immediately affected, and that they should therefore be killed in the manner, during the seasons, and in the States and District hereinafter provided,

Now, therefore, I, D. F. Houston, Secretary of Agriculture, pursuant to authority in me vested by the Migratory-Bird Treaty Act of July 3, 1918, and in conformity with Regulation 10 of the Migratory-Bird Treaty-Act Regulations approved and proclaimed July 31, 1918, do order that until further notice persons may kill by shooting, bobolinks, commonly known as reedbirds or rice birds, from half an hour before sunrise to sunset, from September 1 to October 30, inclusive, in the States of New Jersey,[1] Pennsylvania, Delaware, and Maryland and the District of Columbia, and from August 16 to November 15, inclusive, in the States of Virginia, North Carolina, South Carolina, Georgia, and Florida, but the birds so killed shall not be sold, offered for sale, or shipped for purposes of sale, or be wantonly wasted or destroyed, but they may be used for food purposes by the persons killing them, and they may be transported to hospitals and charitable institutions for use as food.

D. F. Houston,
Secretary of Agriculture.

CANADIAN REGULATIONS UNDER MIGRATORY-BIRDS CONVENTION ACT.

[Promulgated May 11, 1918; amended May 11, 1920.]

1. In these regulations, unless the context otherwise requires:—

(*a*) "Migratory game birds" means the following:

Anatidæ or waterfowl, including brant, wild ducks, geese, and swans;

Gruidæ or cranes, including little brown[,] sandhill, and whooping cranes;

Rallidæ or rails, including coots, gallinules and sora and other rails;

Limicolæ or shorebirds, including avocets, curlew, dowitchers, godwits, knots, oyster catchers, phalaropes, plovers, sandpipers, snipe, stilts, surf birds, turnstones, willet, woodcock, and yellowlegs;

Columbidæ or pigeons, including doves and wild pigeons;

(*b*) "migratory insectivorous birds" means the following:—

Bobolinks, catbirds, chickadees, cuckoos, flickers, flycatchers, grosbeaks, humming birds, kinglets, martins, meadowlarks, nighthawks or bull bats, nuthatches, orioles, robins, shrikes, swallows, swifts, tanagers, titmice, thrushes, vireos, warblers, waxwings, whippoorwill, woodpeckers, and wrens, and all other perching birds which feed entirely or chiefly on insects;

(*c*) "migratory nongame birds" means the following:—

Auks, auklets, bitterns, fulmars, gannets, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, and terns.

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[1] By act of the Legislature of New Jersey in 1921 reedbirds are declared to be nongame birds and their killing is prohibited in the State.

2. *Close seasons.*—No person shall kill, capture, injure, take, molest, sell or offer for sale any migratory game birds except during the following periods in the various Provinces:—

Ducks, geese, brant, or rails.

In Prince Edward Island, Quebec, Ontario, Alberta, Northwest Territories, and Yukon Territory: September 1 to December 14, both dates inclusive.

In Manitoba: September 15 to November 30, both dates inclusive.

In Nova Scotia, New Brunswick, and Saskatchewan: September 15 to December 31, both dates inclusive.

In British Columbia (northern and eastern districts): From the first Saturday next following August 31 in any year to a date 3 months and 15 days later, both dates inclusive.

In that portion of the western district to the north of the fifty-first parallel of latitude: From the first Saturday next following September 7, in any year to a date 3 months and 15 days later, both dates inclusive.

Ducks and rails.

In British Columbia (in that portion of the western district to the south of the fifty-first parallel of latitude): From the first Saturday next following October 14, in any year to a date 3 months and 15 days later, both dates inclusive.

Geese and brant.

In British Columbia (in that portion of the western district to the south of the fifty-first parallel of latitude): From the first Saturday next following November 7 in any year to a date 3 months and 15 days later, both dates inclusive.

Shore birds or waders, including only the following: Woodcock, Wilson or jacksnipe, black-breasted and golden plovers and the greater and lesser yellowlegs.

In Prince Edward Island, Nova Scotia, and New Brunswick: August 15 to November 30, both dates inclusive.

Except that on woodcock and Wilson or jacksnipe the open season in Prince Edward Island, New Brunswick, and Nova Scotia, shall be from September 15 to November 30, both dates inclusive.

In Quebec, Ontario, Alberta, Northwest Territories, and Yukon Territory: September 1 to December 14, both dates inclusive.

Except that on woodcock the open season in Ontario shall be from October 15 to November 14, both dates inclusive.

In Manitoba: September 15 to November 30, both dates inclusive.

In Saskatchewan: September 15 to December 31, both dates inclusive.

In British Columbia (northern and eastern districts): From the first Saturday next following August 31 in any year to a date 3 months and 15 days later, both dates inclusive.

In that portion of the western district to the north of the fifty-first parallel of latitude: From the first Saturday next following September 7 in any year to a date 3 months and 15 days later, both dates inclusive.

In that portion of the western district to the south of the fifty-first parallel of latitude: From the first Saturday next following October 14, in any year to a date 3 months and 15 days later, both dates inclusive.

Provided, however, That Indians and Eskimos may take scoters or "Siwash ducks" for food at any time of the year, but scoters so taken shall not be sold.

For the purpose of this or any other regulation, the Province of British Columbia shall be divided into three districts, to be known as the northern, eastern, and western districts:

Northern district shall mean and include the electoral district of Atlin and all that portion of the Province situated and lying to the north of the main line of the Grand Trunk Pacific Railway and to the east of the summit of the Cascade Range.

Eastern district shall mean and include all that portion of the Province situated and lying to the east of the summit of the Cascade Range and south of the main line of the Grand Trunk Pacific Railway.

Western district shall mean and include all that portion of the Province situated and lying to the west of the summit of the Cascade Range and south of the electoral district of Atlin.

[As amended May 11, 1920.]

3. The killing, capturing, taking, injuring, or molesting of migratory insectivorous birds, their eggs, or nests, is prohibited throughout the year, except as hereinafter provided.

4. The killing, taking, injuring, capturing or molesting of migratory non-game birds or their eggs or nests, except as herein or hereinafter provided, is prohibited throughout the year; *Provided, however*, That Indians and Eskimos may take at any season auks, auklets, guillemots, murres and puffins and their eggs for human food and their skins for clothing, but birds and eggs taken in virtue of this exemption shall not be sold or offered for sale or otherwise traded.

5. A close season shall continue until the 1st day of January, 1928, on the following migratory game birds:—band-tailed pigeons, little brown, sandhill and whooping cranes, swans, curlew, and all shore birds (except the black-breasted and golden plover, Wilson or jack snipe, woodcock, and the greater and lesser yellowlegs). In the Province of British Columbia during such period the close season on cranes, swans, and curlew shall be made by the proper authorities of that Province within the general dates and limitations elsewhere prescribed in these regulations for the respective groups to which these birds belong or greater restrictions on the hunting of these birds shall be made should the aforementioned authorities deem such further restriction desirable as provided by Article III of the Convention between His Majesty and the United States of America, scheduled to chapter 18, 7–8 George V.

6. A close season shall continue until the 1st day of January, 1923, on the wood duck and eider duck, except that in the Province of British Columbia, the wood duck shall be protected by such special means or regulations as the proper authorities of that Province may deem appropriate, as provided by the convention referred to in clause 5.

7. The taking of the nests or eggs of migratory game, migratory insectivorous or migratory non-game birds is prohibited except as otherwise provided in the regulations.

8. *Sale of migratory game birds.*—Notwithstanding any provision of section 2 of these regulations, in the Provinces of New Brunswick, Ontario, Manitoba, Saskatchewan and British Columbia no person shall sell, buy, trade, or traffic in any migratory game bird, killed or taken during the open seasons hereunder.

8A. *Bag limits.*—No person shall kill during any day, or during any season, migratory game birds in the various Provinces in excess of the numbers set forth as follows:—

In Nova Scotia, New Brunswick, Prince Edward Island, Quebec, Ontario, Northwest Territories and Yukon Territory, in any day (except that in Ontario no person shall kill in any one season in excess of 200 ducks).

Ducks.—Twenty-five in the aggregate of all kinds.

Geese.—Fifteen in the aggregate of all kinds.

Brant.—Fifteen in the aggregate of all kinds.

Rails, coots and gallinules.—Twenty-five in the aggregate of all kinds.

Black-bellied and golden plovers and greater and lesser yellowlegs.—Fifteen in the aggregate of all kinds.

Wilson snipe or jack-snipe.—Twenty-five.

Woodcock.—Ten.

Doves.—Twenty-five.

In Manitoba in any day:—

Ducks.—Twenty before October 1st, and 40 thereafter in the aggregate of all kinds.

Geese.—Ten in the aggregate of all kinds.

Brant.—Fifteen.

Rails, coots and gallinules.—Twenty-five in the aggregate of all kinds.

Black-bellied and golden plovers and greater and lesser yellowlegs.—Fifteen in the aggregate of all kinds.

Wilson snipe or jack-snipe.—Twenty-five.

Woodcock.—Ten.

Doves.—Twenty-five.

And in Manitoba in any open season in excess of 250 ducks.

In Alberta in any day:—

Ducks.—Thirty in the aggregate of all kinds.

Geese.—Fifteen in the aggregate of all kinds.

Brant.—Fifteen.

Rails, coots and gallinules.—Twenty-five in the aggregate of all kinds.

Black-bellied and golden plovers and greater and lesser yellowlegs.—Fifteen in the aggregate of all kinds.

Wilson snipe or jack-snipe.—Twenty-five.

Woodcock.—Ten.

Doves.—Twenty-five.

And in Alberta in any open season in excess of 200 ducks.

In Saskatchewan in any day:—

Ducks, geese, and brant.—Fifty in the aggregate of all kinds.

Rails, coots and gallinules.—Twenty-five in the aggregate of all kinds.

Black-bellied and golden plovers and greater and lesser yellowlegs.—Fifteen in the aggregate of all kinds.

Wilson snipe or jack-snipe.—Twenty-five.

Woodcock.—Ten.

Doves.—Twenty-five.

And in Saskatchewan in any open season in excess of 250 birds of the family *Anatidæ*, including *ducks, geese, and brant.*

In British Columbia in any day:—

Ducks.—Twenty in the aggregate of all kinds.

Geese.—Ten in the aggregate of all kinds.

Brant.—Fifteen.

Rails, coots and gallinules.—Twenty-five in the aggregate of all kinds.

Black-bellied and golden plovers and greater and lesser yellowlegs.—Fifteen in the aggregate of all kinds.

Wilson snipe or jack-snipe.—Twenty-five.

Woodcock.—Ten.

Doves.—Twenty-five.

And in British Columbia in any open season in excess of 250 ducks.

And in British Columbia in any open season in excess of 50 geese.

8B. *Shooting restrictions.*—(*a*) No person shall kill or attempt to kill any migratory game birds during the open seasons provided hereunder except with a gun not larger than number 10 gauge.

(*b*) No person shall kill or attempt to kill any migratory game birds by the use of any automatic, swivel, or machine gun or battery or by the use of any aeroplane, power-boat, sailboat, or sunken boat.

(*c*) No person shall kill or attempt to kill any migratory game bird between the hours of sunset and sunrise.

(*d*) No person shall kill or attempt to kill from any motor vehicle or horse-drawn vehicle any migratory game bird.

8C. *Scientific permits.*—Migratory game, migratory insectivorous or migratory non-game birds or parts thereof or their eggs or nests may be taken, bought, sold, shipped, transported or possessed for scientific purposes but only on the issue of a permit by the Minister or by any person duly authorized by him.

Such permits may, upon application, be granted to recognized museums, or scientific societies, and to any person furnishing written testimonials from two well-known ornithologists.

A return of specimens taken under such a permit shall be made to the Minister upon the expiration of the permit.

8D. *Propagation of migratory birds.*—(*a*) Migratory game, migratory insectivorous or migratory non-game birds, or their eggs, protected under regulations made pursuant to the Migratory Birds' Convention Act, may be taken at any time and in any manner for propagating purposes only on the issue of a permit by the Minister or by any person duly authorized by him. Migratory game, migratory insectivorous or migratory non-game birds, or their eggs so taken may be possessed by the permittee and may be sold and transported by him to any person holding a permit for propagating purposes issued by the Minister or by any person duly authorized by him.

(*b*) A person authorized by a permit issued for propagating purposes under this regulation may possess, buy, sell, or transport migratory game, migratory insectivorous, or migratory non-game birds, or their increase of [or] eggs, for propagating purposes. Such migratory game, migratory insectivorous, or migratory non-game birds, except the birds taken under paragraph (*a*) of this regulation, may be killed by him in any manner except by shooting. The unplucked carcasses or the plucked carcasses with heads attached thereto of such birds may be sold and transported by the permittee to any person for consumption, or to the keeper of a hotel, restaurant, or boarding house, or to a dealer in meat or game, or to a club for sale or service to their patrons, all of whom may possess such carcasses for actual consumption without a permit.

(*c*) A person granted a permit under this regulation shall keep books and records which shall correctly set forth at all times the total number of each species of migratory game, migratory insectivorous, or migratory non-game birds or their eggs, taken or in his possession. A written report shall be furnished the Minister during the month of January next following the issuance of the permit. This report shall state the total number of each species reared and killed, the number of each species, or their eggs sold and transported, the manner in which such species or eggs were transported, the name and address of each person from or to whom such species or eggs were purchased or sold together with number and species and whether sold alive or dead; and the date of each transaction.

(*d*) Application for permits to take such birds for propagating purposes shall be accompanied by a statement showing:

(1) The full name and Post Office address of the applicant.

(2) The species of birds or eggs that it is desired to take.

(3) The number.

(4) The place at which the birds or eggs are to be taken.

Applications for permits to possess, buy, sell, or transport such birds for propagating purposes shall be accompanied by a statement showing:

(1) The full name and Post Office address of the applicant.

(2) The species and number of birds that it is desired to possess.

(3) The area and location of the land to be used in the business and whether owned or leased by the applicant.

(*e*) The Minister may require an applicant to furnish a bond in support of his application for a permit for propagating purposes.

(*f*) A permittee shall at all reasonable hours allow any game officer to enter and inspect the premises where operations are being carried on under these regulations and to inspect the books and records of such permittee relating thereto.

(*g*) No person holding a permit for propagating purposes shall sell migratory game, migratory insectivorous, or migratory nongame birds, raised and killed in captivity unless the same shall bear a metal tag. This tag shall be of a type approved by the Minister and shall contain the name or initials of the holder of the permit. It shall not be removed from the carcass.

8E. *Termination of permits.*—All permits and licenses shall terminate at the end of the calendar year in which they shall have been issued. They shall not be transferable and shall be revocable at the discretion of the Minister.

8F. *Taxidermists.*—No person shall engage in the business of a taxidermist without having first secured from the Minister a license so to do. The fee for this license shall be one dollar.

No taxidermist shall receive, prepare for exhibition purposes, or possess, any migratory game, migratory insectivorous, or migratory nongame bird, or any portion thereof, unless such bird has been legally killed, either in the open season for such bird, or by the holder of a permit for taking birds for scientific purposes.

Every licensed taxidermist shall annually make such returns as the Minister may require.

Every licensed taxidermist shall keep books and records which correctly set forth the name of each migratory game, migratory insectivorous, or migratory nongame bird received, the date and locality of capture, the date received, and the name and address of the owner of such bird. These books and records are to be open to inspection by any game officer at any reasonable time.

8G. *Labeling packages for shipment.*—Any package in which migratory game, migratory insectivorous, or migratory non-game birds or parts thereof, or their eggs or nests, are shipped or transported for scientific or propagating purposes shall be clearly marked on the outside with the number of the permit, the name and address of the shipper and an accurate statement of the contents.

No transportation company shall accept for transportation any package containing eggs, nests, or parts of migratory game, migratory insectivorous, or migratory non-game birds unless such packages shall be marked as hereinbefore required, and shipment of the same through the mails is prohibited, unless marked as aforesaid.

[As amended May 11, 1920.]

9. The shipment or export of migratory game, migratory insectivorous, or migratory non-game birds or their eggs from any Province during the close season in such Provinces is prohibited except for scientific or propagating pur-

poses and traffic between Canada and the United States in any such birds, or their eggs captured, killed, taken or shipped at any time contrary to the laws of the Province or State in which the same are captured, killed, taken or shipped, is likewise prohibited.

10. No person shall ship or offer for shipment from Canada to the United States any package containing migratory game, migratory insectivorous or migratory non-game birds, or any parts thereof or their eggs unless such package shall have the name and address of the shipper and an accurate statement of the contents clearly marked on the outside of such package.

No transportation company shall accept for transportation to the United States, any packages of migratory game, migratory insectivorous, or migratory non-game birds or any parts thereof or their eggs unless such packages bear the name and address of the shipper and an accurate statement of the contents, and shipment of the same through the mails is prohibited unless marked as aforesaid.

11. If any of the migratory game, migratory insectivorous or migratory non-game birds should, under extraordinary conditions become seriously injurious to agricultural, fishing or other interests in any particular locality the Minister may issue permits to kill such birds so long as they shall continue to be injurious. Applications for such permits shall include a full statement describing:

(1) The species and an estimate of the number of birds committing the damage.

(2) The nature and extent of the damage.

(3) The extent of the agricultural or other interests threatened or involved.

Such permits shall be revocable at the discretion of the Minister. On the expiration of the permit the person to whom it is issued shall furnish to the Minister a written report showing the number of birds killed, the dates upon which they were killed, and the disposition made of the dead birds.

No birds killed under such permits shall be shipped, sold, or offered for sale.

12. *Introduction of Foreign Species of Migratory Birds without Consent Prohibited.*—No person or organization shall introduce for the purpose of sport or acclimatization any species of migratory birds without the consent of the Minister in writing.

CANADIAN TARIFF ACT PROHIBITING IMPORTATION OF PLUMAGE.

The importation of bird plumage into Canada for millinery purposes is prohibited by tariff item 1212 under schedule C (prohibited goods) to the customs tariff, section 5, by the enactment of the Canadian customs tariff act of 1914. Item 1212 prohibits the entry of the following:

1212. Aigrettes, egret plumes, or so-called osprey plumes, and the feathers, quills, heads, wings, tails, skins, or parts of skins of wild birds either raw or manufactured; but this provision shall not come into effect until January 1, 1915, and shall not apply to—

(*a*) The feathers or plumes of ostriches;

(*b*) The plumage of the English pheasant and the Indian peacock:

(*c*) The plumage of wild birds ordinarily used as articles of diet;

(*d*) The plumage of birds imported alive, nor to

(*e*) Specimens imported under regulations of the minister of customs for any natural-history or other museum or for educational purposes.

OFFICIALS FROM WHOM COPIES OF GAME LAWS MAY BE OBTAINED.

Alabama: Commissioner of conservation, Montgomery.

Alaska: The governor, Juneau; Secretary of Agriculture, Washington, D. C.

Arizona: State game warden, Phoenix.

Arkansas: Secretary, game and fish commission, Little Rock.

California: Executive officer, fish and game commission, Postal Telegraph Building, San Francisco.

Colorado: State game and fish commissioner, Denver.

Connecticut: Secretary, commission of fisheries and game, Hartford.

Delaware: Chief game warden, Dover.

District of Columbia: Superintendent Metropolitan police.

Florida: Secretary of State, Tallahassee.

Georgia: Game and fish commissioner, Atlanta.

Idaho: Fish and game warden, Boise.

Illinois: Chief game and fish warden, Springfield.

Indiana: Superintendent, division of fisheries and game, State House, Indianapolis.

Iowa: State fish and game warden, Lansing.

Kansas: State fish and game warden, Pratt.

Kentucky: Executive agent, game and fish commission, Frankfort.

Louisiana: Commissioner of conservation, Court Building, New Orleans.

Maine: Commissioner of inland fisheries and game, State House, Augusta.

Maryland: State game warden, 512 Munsey Building, Baltimore.

Massachusetts: Director, division of fisheries and game, State House, Boston.

Michigan: Director, department of conservation, Lansing.

Minnesota: Game and fish commissioner, St. Paul.

Mississippi: Secretary of State, Jackson.

Missouri: Game and fish commissioner, Jefferson City.

Montana: State fish and game commission, Helena.

Nebraska: Chief game warden, Lincoln.

Nevada: Secretary of State, Carson City, and county commissioners.

New Hampshire: Fish and game commissioner, Sunapee.

New Jersey: Secretary, board of fish and game commissioners, Trenton.

New Mexico: Secretary, game and fish department, Santa Fe.

New York: Secretary of conservation commission, Albany.

North Carolina: Secretary, Audubon Society of North Carolina, Raleigh.

North Dakota: Secretary, game and fish board, Steele.

Ohio: Chief game warden, board of agriculture, Columbus.

Oklahoma: State game warden, Oklahoma City.

Oregon: State game warden, Portland.

Pennsylvania: Secretary, board of game commissioners, Harrisburg.

Rhode Island: Chairman, commissioners of birds, Providence.

South Carolina: Chief game warden, Columbia.

South Dakota: State game warden, Pierre.

Tennessee: State game and fish warden, Nashville.

Texas: Game, fish, and oyster commissioner, Austin.

Utah: Fish and game commissioner, Salt Lake City.

Vermont: Fish and game commissioner, Montpelier.

Virginia: Commissioner of game and inland fisheries, Richmond.

Washington: Director of fisheries and game, Olympia.

West Virginia: Game and fish commission, Charleston.

Wisconsin: Secretary, conservation commission, Madison.

Wyoming: State game warden, Cheyenne.

Dominion legislation: Commissioner of parks, Ottawa.

Alberta: Chief game guardian, Edmonton.

British Columbia: Secretary, game conservation board, Vancouver.

Manitoba: Chief game guardian, Winnipeg.

New Brunswick: Chief game and fire warden, Fredericton.

Northwest Territories: Commissioner of parks, Ottawa.

Nova Scotia: Chief game commissioner, Halifax.

Ontario: Superintendent game and fisheries, Toronto.

Prince Edward Island: Chief game officer for migratory birds, Maritime Provinces, Wolfville, Nova Scotia.

Quebec: General inspector of fisheries and game, Quebec.

Saskatchewan: Chief game guardian, Regina

Yukon: Gold commissioner, Dawson.

Colony of Newfoundland: Secretary, game and inland fisheries board, St. Johns.

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U. S. DEPARTMENT OF AGRICULTURE
FARMERS' BULLETIN No. 1236

CORN AND ITS USES AS FOOD

THE ORDINARY DIET in this country includes some vegetables and fruits, some flesh foods, dairy products, and eggs, some fats, some sugar and other sweets, and some of the starchy cereal foods such as corn, wheat, rice, or oats. As far as food values are concerned it makes little difference which cereal is used in such a diet and one kind may be substituted for another more or less as convenience, price, and personal preference suggest. The cereals may also be used in place of such starchy vegetables as potatoes, sweet potatoes, and beans, providing other kinds of vegetables and fruits are present in reasonable amounts. Thus, when corn is abundant and cheap or when any of the other starchy foods are scarce and dear, one may increase the use of corn and decrease the use of the other cereal or starchy vegetable without fear of harm.

This bulletin tells about the value of corn as human food and gives practical suggestions and recipes for using corn preparations in a variety of ways.

Washington, D. C. February, 1923

CORN AND ITS USES AS FOOD.

Prepared in the Office of Home Economics, States Relations Service.

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CORN is the cereal most closely associated with America and is native to this hemisphere. It is now commonly cultivated for human food in other parts of the world where there is warmth and sunshine enough for it to reach best development, but it was first used in America. The carvings left on the buildings of the little-known Maya race in Central America show that it was used as a religious symbol of prosperity long before the time of Columbus. The first white settlers quickly learned from their Indian neighbors to grow and prepare it, and it still maintains a prominent place among our cereal foods.

Its importance here is shown by the fact that with us the word "corn" has come to refer almost entirely to this one cereal, *Zea mays*, whereas in other English-speaking regions it still refers to cereals in general and the word "maize" is used for what we commonly call corn. Wheat is now more generally used for bread making, but corn forms a basis of many popular breads and cakes. At ordinary prices corn preparations are among the more economical of our common foods, and, as many palatable and wholesome dishes can be made from them, their use may well be increased.

WAYS IN WHICH CORN IS USED FOR HUMAN FOOD.

There are various ways in which corn is prepared for use as human food. The grain is parched and eaten whole; it is ground to varying degrees of fineness to make hominy, corn meal, and corn flour; it is treated with alkali to remove the skin and germ to make lye hominy or hulled corn; or it is prepared by special processes to make a variety of breakfast foods.

The starch is sometimes separated out and sold as cornstarch; it is also made into glucose, much used by confectioners and in table sirups, and into such sugars as corn sugar (also called cerelose or bread sugar), and anhydrous glucose, a product sometimes employed in invalid dietetics.

The fat in the germ is separated out and prepared for use as table oil and in cooking.

Recently phytin, a phosphorus compound, has also been separated from the corn on a commercial scale and is attracting attention as a possible means of introducing organic phosphorus into diets that are poor in that important element.

The half-ripe corn, especially of certain sweet varieties, is eaten as a vegetable, either fresh or canned, while the ripe kernels of other varieties are used for pop corn.

FOOD VALUE.

Corn and the other cereals, such as wheat, rice, and oats, form a group of foods that contain a large amount of starch and an amount of protein that is at least above the average for food materials in common use. Studies of actual dietaries show that the amount of cereal food consumed in the form of breakfast foods, bread, cake, or otherwise, averages at least about 10 ounces a man a day. This is the equivalent of two generous servings of cooked cereal, 8 ounces of bread, and 1½ ounces of flour or meal used in general cooking. Equivalent figures for the average weekly consumption of cereals by the type family of two adults and three children are 10 pounds of bread and 7½ pounds of flour, meal, breakfast foods, and other dry cereal preparations. These amounts yield about 30 per cent of the total energy of the average diet and about 35 per cent of the total protein. These amounts may be increased to 12 to 14 ounces a man a day, or to the equivalent of 12 pounds of bread and 9 pounds of dry cereal a family a week if care is taken in the preparation of the cereal foods and also in the selection of other foods to go with them. In general, the most economical and at the same time adequate diets are those in which generous amounts of cereal foods are combined with reasonable amounts of other kinds of food. Such questions are discussed more fully in other publications of this series.[1]

To make a diet which meets all the nutritive needs of the body, any of the cereals must be supplemented by meat or other flesh foods, milk and its products, eggs, vegetables, and fruits. Some of these foods supplement the proteins of the cereals which are not of a kind to meet all the needs of the body for protein, and some supply mineral matter and vitamins in which the cereals are lacking. Scrapple, an old fashioned Pennsylvania-German dish now produced commercially as well as at home, is made by cooking corn meal with pork trimmings, and is a good example of a combination in which the incomplete protein of the cereal is supplemented by a little of the more nearly complete protein of the meat.

The cereals contain, roughly stated, from 7 to 16 per cent protein, from 70 to 80 per cent carbohydrates (principally starch but including also small amounts of cellulose), and from 1 to 7 per cent fat, while a pound furnishes from 1,600 to 1,800 calories of energy. Corn contains about as much starch as the average for the cereals, slightly less protein, and more fat, and its energy value is slightly greater.

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[1] U. S. Dept. Agr., Farmers' Buls. No. 808, How to Select Foods. I. What the Body Needs; No. 817, How to Select Foods. II. Cereal Foods; No. 1313, Good Proportions in the Diet.

Since in determining the general food values in the ordinary mixed diet the food values of the cereals may be considered interchangeable, a person can tell fairly well which is the more economical simply by comparing prices per pound. For example, if hominy and rice cost the same, it is largely a matter of personal preference and convenience which shall be chosen, but if either is cheaper or more abundant, it may quite safely be substituted for the other.

The various cereals differ considerably in bread-making qualities. Corn is used for a variety of quick breads very popular in many parts of the United States, but it can not be used like wheat flour in making yeast-raised bread, because it does not contain the necessary gluten. During the war, when it was considered a patriotic duty to save wheat, it was found that corn meal or corn flour could be easily substituted for more or less of the wheat flour in many recipes for quick breads, and similar substitutions should be remembered when corn is especially cheap or abundant (pp. 11–15). Many of the corn breads are prepared with milk and eggs, which render them more nearly complete foods than breads made principally of flour or meal.

The way in which corn or any other cereal is prepared may change the food value more or less. Cornstarch and corn oil, each of which represents only one of the nutrients found in the whole grain, of course differ from the whole grain in food value as well as in appearance and use. The amount of the skin and germ (fig. 1) that is removed when the grain is ground into hominy, meal, or flour also makes the products differ in their value to the body.

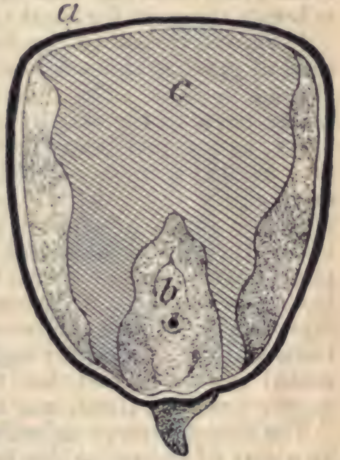

FIG. 1.—Diagrammatic section of a grain of corn: *a*, Skin; *b*, germ; *c*, endosperm.

When the skin or bran is left in, the product contains more of the mineral substances needed by the body, a trifle more protein, and more of vitamin B. It also contains much more cellulose. This may be helpful in counteracting constipation, but it may lessen the amount of nutrients which the body digests and utilizes. The rough particles of the cellulose may injure the delicate lining of the digestive tract of babies and persons suffering from certain disorders, though they are not harmful to normal persons.

The germ contains most of the fat of the grain, and in or around it is found the vitamin A. Removing it therefore decreases the food value of the product. Unfortunately the germ is the part of the grain that spoils first, so that retaining the germ lessens the keeping quality of the product.

Removing the skin and the germ thus has both advantages and disadvantages. If the product can be used soon after grinding or if the diet is poor in animal foods, fruits, and vegetables, it may be wise to choose the preparations that contain all parts of the grain. If the product must be kept for a long time and if the diet is fairly varied, the decorticated, degermed products may be preferred.

The varieties of corn commonly used for making hominy, meals, and breakfast cereals are similar in composition, though they may differ in flavor and appearance. White corn is, as a rule, milder in flavor than yellow. The preference for one sort or another is largely personal or local. White corn is preferred generally in the Southeastern States and in some parts of New England, and yellow through the Northern States as a whole, while the blue, black, and red varieties have always been used in parts of the Southwest where Mexican influence is marked.

Whatever variety is chosen, only clean, sound, properly stored corn should be used for human food. It is impossible to get a good product from grain that has been kept in damp, rat-ridden cribs. New corn is better than old for meal and hominy.

Corn and the other common cereals are wholesome foods, and one kind of grain is about as easily and thoroughly digested as another by normal persons. The fineness of grinding and the removal of the coarse parts of the skin or bran make some difference in the digestibility, as has just been shown, but not enough to be very important to a healthy person. Cooking the cereals undoubtedly makes them more easily and quickly digested by softening them and giving the digestive juices a better chance to act on the nutrients, and it also makes them more palatable to most persons. It was formerly supposed that uncooked starch was not digested, but recent experiments have proved that it is digested by normal adults, the completeness of digestion depending apparently on the size of the starch granules. Corn and rice starch, for example, were found to be as completely digested raw as cooked, but the raw potato starch, which was much more coarsely grained, was less thoroughly digested than the cooked.

The disease known as pellagra was formerly supposed to be caused by a sort of poisoning due to corn or to a fungus growing in spoiled corn, but this has been completely disproved. The reason why the theory was ever set up is that the disease was first studied in southern Europe among people who lived almost exclusively on corn. Pellagra is now believed to be largely, if not entirely, caused by restricted diets which do not supply all the necessary food ingredients, particularly by those which furnish little or no flesh foods, eggs, dairy products, fresh vegetables, or fruits. The best way to guard against it is to try to use these foods freely. If they are hard to secure in abundance it is wise to choose "old-process" corn meal (see p. 7), whole-wheat flour, and unpolished rice rather than the preparations from which the skin and germ of the grain have been more completely removed.

Corn, like rice, is often served as a vegetable with meat in the place of such starchy vegetables as potatoes, sweet potatoes, and beans. These cereals are rather similar to these vegetables as a source of protein and energy, but are not as good a source of mineral matters and vitamins as are most vegetables and fruits. Consequently, when corn takes the place of a vegetable one should make sure that the diet includes a sufficient amount of other vegetables or fruit. The chemical composition of the corn kernel and of a variety of corn products is given in the following table, which also includes some other cereals and vegetable foods for comparison. In studying the figures in this table it should be remembered that they do not show either the vitamins furnished by the different materials nor how completely the protein from the various foods meets the needs of the body.

Composition and energy value of corn, corn products, and other food materials.

Food materials.	Refuse.	Water.	Protein.	Fat.	Carbohydrate.	Mineral matter.	Energy value per pound.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*
Corn, whole grain		10.8	10.0	4.3	73.4	1.5	1,690
Corn, breakfast food, flake and parched		7.3	10.1	1.8	78.4	2.4	1,680
Corn meal:							
Old process, unbolted		12.0	8.7	4.7	73.3	1.3	1,680
Old process, bolted		12.0	8.9	4.9	73.2	1.0	1,690
New process or granular		12.5	9.2	1.9	75.4	1.0	1,615
New process or granular, boiled		85.5	1.5	.3	12.6	.1	270
Hominy:							
Coarse		10.8	8.3	.5	80.1	.3	1,625
Fine		11.0	9.4	.7	78.6	.3	1,625
Lye or hulled corn		74.1	2.3	.9	22.2	.5	480
Boiled		79.3	2.2	.2	17.8	.5	370
Corn flour		12.6	7.1	1.3	78.4	.6	1,605
Cornstarch					90.0		1,635
Corn sirup (glucose)		16.0			83.5	.5	1,515
Corn oil				100.0			4,085
Pop corn		10.7	11.2	5.2	71.4	1.5	1,710
Popped corn		4.3	10.7	5.0	78.7	1.3	1,825
Sweet corn:							
On cob	61.0	29.4	1.2	.4	7.7	.3	180
Edible portion		75.4	3.1	1.1	19.7	.7	460
Canned		76.1	2.8	1.2	19.0	.9	445
Oats, whole grain		11.0	11.8	5.0	69.2	3.0	1,675
Rice, whole grain		12.0	8.0	2.0	77.0	1.0	1,625
Wheat, whole grain		10.6	12.2	1.7	73.7	1.8	1,630
Wheat flour, white		12.0	11.4	1.0	75.1	.5	1,610
Wheat bread, white		35.3	9.2	1.3	53.1	1.1	1,185
Potatoes:							
White, as purchased	20.0	62.6	1.8	.1	14.7	.8	305
White, edible portion		78.3	2.2	.1	18.4	1.0	380
White, boiled		75.5	2.5	.1	20.9	1.0	430
Sweet, as purchased	20.0	55.2	1.4	.6	21.9	.9	445
Sweet, edible portion		69.0	1.8	.7	27.4	1.1	560

CORN MEAL.

Corn meal is the form in which corn is perhaps most commonly used for human food. In primitive times it was ground with stones by pounding and crushing the dry, ripe grain in a hollow log (fig. 2) or on a flat or hollowed stone. Gradually mills were developed, at first turned by hand and later by water power. Gradually also methods of winnowing and sifting or bolting were improved so that more or less of the skin and germ could be removed.

Nowadays there are two general ways of grinding corn meal, one sometimes called "old process" and the other "new process."

"Old-process" meal is also known as "water ground," because the mills in which it used to be made were run by water power. Small water-turned mills are still to be found here and there through the Southeastern States, but this type of meal is now also made in large modern mills equipped with electricity and elaborate devices for cleaning and bolting. A better name would be "stone ground," for in all "old-process" mills the corn is crushed between stones.

White corn is most commonly used. The skin and germ are not removed before grinding, and although more or less of them are bolted out, some of the skin and a large proportion of the germ remain in the finished meal, even in the most finely ground. The method of grinding makes stone-ground meal feel soft to the touch. The pres-

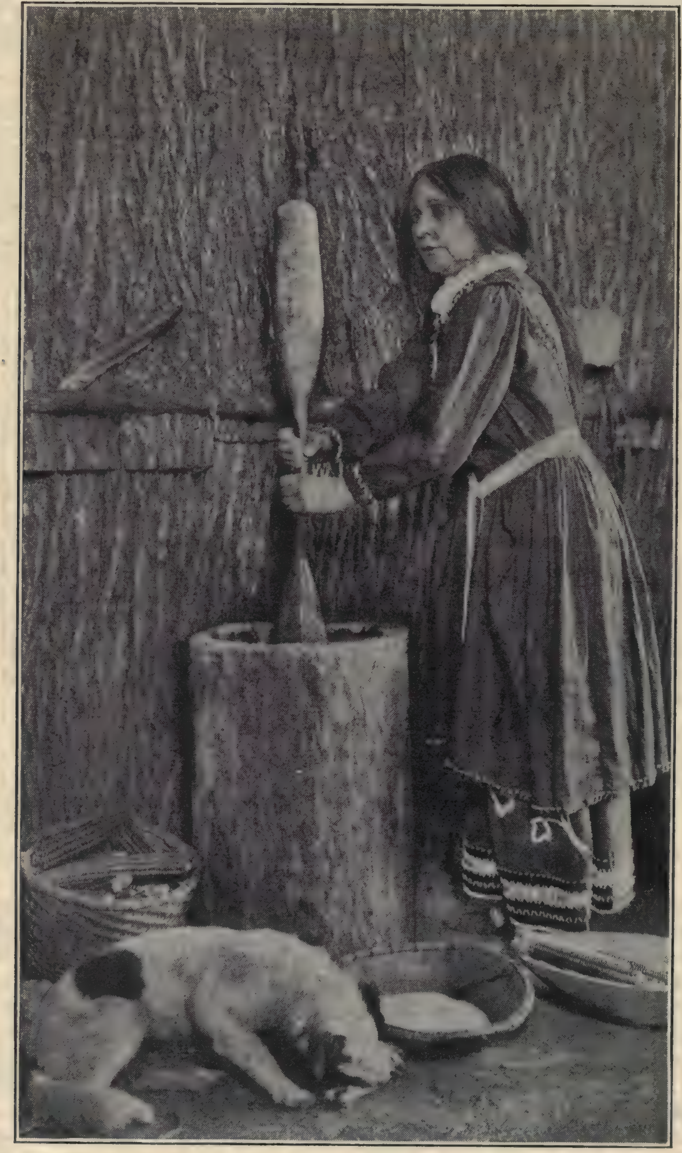

FIG. 2.—A primitive implement used by the American Indians and early colonists in preparing hominy and corn meal.

ence of the germ gives it what many consider a richer flavor. This type of meal can not be kept indefinitely, and is chiefly supplied by local mills rather than from large distributing centers. In parts of the South people still take their home-grown corn to the near-by mill and bring away freshly ground meal or hominy.

"New-process" meal is ground between steel rollers or steel disks in mills provided with intricate modern equipment. Both white and yellow corn are used, the yellow being more common in the North.

During milling the bran and germ are broken and largely, but not entirely, removed. The remainder of the grain is then used to make hominy, grits, meal, or flour. Very little of the skin is found in these products, the greater part going into others used for feed and by brewers. "New-process" corn meal feels dry and granular when rubbed between the fingers. It keeps well and can be obtained all over the country except where the old-fashioned meal is still preferred.

These differences in the types of corn meal make it hard to give recipes that will produce equally good results in all parts of the country. Many believe that the granular, "new-process" meal usually found in the North requires more and longer cooking than the "old-process" meal, popular in the South. For breads which are made with baking powder or eggs or in which corn meal is mixed with white flour the two kinds of corn meal may be treated in much the same way, but for waffles, doughnuts, and some kinds of bread the granular meal should be softened by scalding before it is mixed into a batter.

Each locality where corn is used in large amounts seems to have worked out its own peculiar dishes.

The southern cook made hoecake or corn pone by mixing corn meal and water and sometimes a little fat into a dough and cooked it on a board before an open fire or baked it in the oven. The early New Englander made similar cakes, which, when baked before the fire, were sometimes basted with cream to make them richer. The New Englander also had his "hasty pudding," made by cooking corn meal in a large quantity of water—a very common article of diet. This was made thick enough so it could be eaten as a mush with milk when hot and fried in slices when cold. The American Indians made many kinds of corn bread and often mixed meats, peppers, or other food materials with the dough.

Besides these simple dishes, various peoples have worked out combinations of corn meal with foods differing from it widely in composition. In many cases the materials added furnish the necessary food ingredients that are lacking in the corn. For example, almost every locality which uses corn meal in large amounts has a characteristic dish in which it is used with milk, cheese, meat, or other foods that supply more adequate protein than does the corn. Probably the best-known dishes of this kind in the United States are the mush and milk of the earlier settlers of New England and the hoecake and buttermilk of the South. "Stamp and go," a favorite dish among the natives of Jamaica, is made up of salt fish, lard, and corn meal (for a similar dish, see the recipe for corn-meal fish balls on p. 16), and has a nutritive value like that of scrapple (see p. 15). The use of cheese, which consists chiefly of an excellent form of fat and protein, with polenta (see below), may be considered an instinctive attempt by the Italians to satisfy the physiological food requirement by means of a single dish.

Most of the dishes mentioned above had their origin where life was simple and where few dishes were served at a meal. In most American homes of the present, meals consist not of one but of several dishes, and there is a considerable variety of food materials used in the course of a day or a week. When the protein foods and the fruits and vegetables are represented sufficiently in other dishes there is, of course, no necessity for providing these in the same dish with the corn meal.

Suggestions and recipes for using corn meal in various ways are given beyond. It should also be remembered that corn meal may be substituted for all or part of the wheat flour in many recipes for quick breads, muffins, griddlecakes, and cookies, using a scant cup of meal in place of a level cup of flour, baking more slowly and longer, and dropping rather than rolling out biscuit.

CORN-MEAL MUSH.

Corn-meal mush is made by cooking the meal in salted water. To produce a satisfactory flavor it should reach the boiling point at some time during the cooking. An old method is to allow the water to come to the boiling point and to add the meal slowly, stirring constantly. The objections to this are that there is considerable danger that the mush will become lumpy and that it is often unpleasant for the cook to stand over a hot stove and stir the mixture sufficiently to make it smooth. A better method, therefore, is the following:

Put the corn meal, cold water, and salt together in the top of a double boiler. No stirring is necessary. Put the top of the double boiler into the lower part and allow the mush to heat slowly, cooking half an hour, or longer, if convenient. Many people cook it as long as four hours. For each cup of meal allow from 1 to 1½ level teaspoons of salt and from 3½ to 4½ cups of water, depending on the length of cooking. Milk may be added in place of part or all of the water. Just before serving remove the top of the double boiler from the lower part and boil the mush for two or three minutes. In boiling it at this time there is no danger that it will lump.

This general method, though seldom the same proportion of water to meal, may be followed whenever cooked corn meal is to be used in the dough or batter for bread, doughnuts, or other dishes. In these cases, however, the final boiling is not necessary, for the meal is sufficiently heated later.

POLENTA.

This dish, which is common in Italy, differs little, except in name, from corn-meal mush, though it is served in very different ways. Sometimes cheese is added during the cooking. Polenta is often reheated either with tomato sauce or a meat gravy left over from a meal, or with a meat gravy made from a small amount of meat bought for the purpose, or with half tomato sauce and half meat gravy. In any case, the dish is improved by sprinkling the cooked polenta with cheese. When the polenta is to be reheated in gravy, it is well to cut it into small pieces in order that the gravy may be well distributed through the dish.

SAUCES FOR POLENTA.

TOMATO SAUCE.

2 tablespoons butter.
2 tablespoons flour.
1 cup thick strained tomato juice.
Salt and pepper.

Melt the butter; cook the flour thoroughly in it; add the tomato juice and seasonings; and cook until smooth, stirring constantly.

SAVORY SAUCE.

Take 2 ounces of salt pork, bacon, or sausage. If bacon or pork is used, cut it into small pieces. Heat until crisp but not burned. In the fat which separates out from the meat, cook a small amount of finely chopped onion and red or green pepper, being careful not to burn them. Add 1 cup of thick tomato juice or a larger amount of uncooked juice, and cook the mixture until it is reduced to a cupful. Season with salt. To this sauce capers, mushrooms, or finely chopped pickle may be added.

FRIED CORN-MEAL MUSH.

The custom of packing hasty pudding in granite pans, cutting it into slices, and frying it is too common to call for special mention here. A less common method in this country is that employed in Italy, where polenta is usually spread out in thin layers on a board and cut into small blocks. These blocks are egged and crumbed, and fried in deep fat. Another method is to mix corn meal in three times its volume of water and to cook it in water only long enough to form a mush, and to complete the cooking by frying the mush in butter or other fat. This is not so stiff as ordinary fried corn-meal mush, and has the advantage of requiring a shorter time for its preparation, as the temperature of fat suitable for frying is far greater than that of boiling water.

BAKED CORN-MEAL MUSH.

When corn-meal mush is partly done, pour it into shallow pans, making a layer not more than 2 inches thick, and cook in an oven until it is well browned.

BUTTERMILK CORN-MEAL MUSH.

White corn meal cooked in buttermilk makes a dish which resembles cottage cheese in flavor. It may be eaten hot, but is especially palatable when served very cold with cream. For this purpose it is sometimes molded in cups. In making it, allow 1 part of corn meal to 6 parts of buttermilk and 1 teaspoon of salt to each cup of meal.

CORN-MEAL MUSH WITH CHEESE.

For this dish yellow corn meal is generally used, and the cheese may be added just before the mush is taken from the fire. For a mush made with 1 cup of yellow corn meal the usual allowance is one-half cup, or 2 ounces, of grated cheese. There is, however, no limit to the quantity of cheese which can be added, and the addition of the cheese tends to make not only a more highly nitrogenous and nourishing dish but also one which can be eaten without the addition of butter or cream. Like the ordinary corn-meal mush, it is often fried either in deep fat, after having been egged and crumbed, or in a small amount of fat, or baked.

CORN-MEAL BREADS.

CORN PONE.

2 cups corn meal.
⅓ cup water
⅓ cup sour milk or buttermilk.
¼ teaspoon soda.
¼ cup wheat flour.
1 teaspoon salt.
1 tablespoon sugar.
2 teaspoons baking powder.

Either pour the water and milk over the corn meal in a double boiler and cook a few moments or boil the water and pour it over the corn meal; then add the buttermilk. Sift together the flour, salt, sugar, baking powder, and soda and add to the corn meal when it is cool. The mixture should be just stiff enough to make into cakes or "pones." If it is stiffer than this, add a little water. Form into cakes and place in a hot, well-greased pan and bake in a hot oven until brown. The cakes should be handled lightly and not pressed down after they have been placed in the pan.

CRACKLING BREAD.

For each cup of corn meal allow three-fourths teaspoon salt and half a cup of cracklings, the crisp brown particles that are left after lard is rendered. If the cracklings contain a great deal of fat, place them while warm in a piece of cheesecloth and squeeze out part of the fat. Pour boiling water over the meal till it is of such consistency that it can be mashed with the hand. Add the cracklings, shape into cakes, and bake.

CRISP CORN-MEAL CAKE.

3 cups milk.
1 teaspoon salt.
1½ cups corn meal.

Mix the ingredients and spread on shallow buttered pans to a depth of about one-fourth of an inch. Bake in a moderate oven until crisp.

This will serve 6 persons.

SOUTH CAROLINA YEAST CORN BREAD.

1½ quarts of fine corn meal.
2½ quarts wheat flour.
or
2½ quarts fine corn meal.
1½ quarts wheat flour.
2 teaspoons salt.
1 pint mashed sweet potatoes.
1 cake yeast, dry or compressed.

FIG. 3.—Risen bread in which wheat flour was partly replaced by corn meal.

Mix 1 pint each of the corn meal and the flour and add warm water enough to form a stiff batter. Add the yeast cake, mixed with a small amount of water. Keep this sponge in a warm place until it becomes light. Scald the remaining meal with water, and as soon as it is cool enough add it to the sponge, with the flour, potatoes, and salt. The dough should be just thick enough to knead without danger of it sticking to the board. Experience will teach how much water to use to secure this end. Knead well and put in a warm place to rise. When it is light, form into loaves, put into bread pans, and let it rise until its volume is doubled. Bake in a moderate oven.

RAISED CORN-MEAL MUFFINS.

1 cup scalded milk.
3 tablespoons butter or other fat.
4 tablespoons sugar.
1 teaspoon salt.
¼ yeast cake.
¼ cup lukewarm water.
1 cup corn meal.
1½ cups wheat flour.

Add the shortening, sugar, and salt to the milk. When lukewarm add the yeast softened in the water, the corn meal, and the flour. Beat well; lest rise over night. Beat well and half fill greased muffin rings. Let rise until nearly double and bake in a hot oven for half an hour.

This makes 12 muffins.

BOSTON BROWN BREAD.

1 cup corn meal.
1 cup rye meal.
1 cup graham flour.
2½ teaspoons soda.
4 teaspoons baking powder.
1 teaspoon salt.
¾ cup molasses.
2 cups sour milk, or
1¾ cups sweet milk.

Mix and sift the dry ingredients and add the molasses and milk. Beat thoroughly and steam 3½ hours in well-buttered covered molds. Remove the covers and bake the bread long enough to dry the top.

This may be made also with 1½ cups each of corn meal and rye meal and no graham flour. A cup of seeded and shredded raisins or prunes or a cup of Zante currants may be added.

This serves 8 persons.

SOUR-MILK CORN BREAD.

2 cups corn meal.
2 cups sour milk.
2 tablespoons butter.
2 tablespoons sugar, white or brown.
1½ teaspoons salt.
2 eggs.
1 teaspoon soda.
1 tablespoon cold water.

There are two ways of mixing this bread, and also those in the four following recipes, all of which include milk and eggs. By the first method the meal, milk, salt, butter, and sugar are cooked in a double boiler for about 10 minutes. When the mixture is cool the eggs, well beaten, are added, and the soda, dissolved in the water. By the other method all the dry ingredients, including the soda, are mixed together, and then the sour milk and eggs well beaten and the butter are added. If the second method is followed the cold water is not needed. The bread should be baked in a shallow iron or granite pan for about 30 minutes.

Since the bread made by the first method is of much better texture, that method is to be preferred except in cases where there is not time for the necessary heating and cooling of the meal.

Buttermilk may be substituted for the sour milk, in which case the butter should be increased slightly; or sour cream may be used and the butter omitted.

This serves 6 persons.

SPIDER CORN BREAD.

1½ cups corn meal.
2 cups sour milk and
1 teaspoon soda;
or,
1¾ cups sweet milk and
3 teaspoons baking powder
1 teaspoon salt.
2 eggs.
2 tablespoons butter.

Mix as in the preceding recipe save that the fat should be used to grease an iron spider. Heat the spider, pour in the batter, and bake on the middle shelf of a hot oven.

SOUTHERN CORN MUFFINS.

These are made like the spider corn bread in the preceding recipe save that 2 cups of corn meal are used and the dough placed in hot, greased iron muffin pans and baked about 20 minutes in a fairly hot oven.

CUSTARD CORN CAKE.

2 eggs.
¼ cup sugar.
1 teaspoon soda.
1 teaspoon salt.
1 cup sour milk.
1 cup sweet milk.
1⅔ cups corn meal.
⅓ cup wheat flour.
2 tablespoons butter.
1 cup cream.

Mix all the ingredients but the cream and butter as directed for sour-milk corn bread (see above). Melt the butter in a deep pan, using plenty on the sides. Pour in the batter, add (without stirring) a cup of cream, and bake 20 to 30 minutes. When cooked there should be a layer of custard on top of the cake or small bits of custard distributed through it.

For economy's sake milk may be used in place of the cream in this recipe.

This serves 6 persons.

SPOON CORN BREAD.

2 cups water.
1 cup milk.
1 cup white corn meal.
1 tablespoon butter.
1 teaspoon salt.
2 eggs.

Mix as directed for sour-milk corn bread (see above). Add the eggs well beaten and the other ingredients. Beat thoroughly and bake in a well-greased pan for 25 minutes in a hot oven. Serve from the same dish with a spoon.

This serves 6 persons.

SWEET-MILK CORN BREAD.

2 cups yellow corn meal.
1 cup wheat flour.
2 cups milk.
½ cup sugar.
1 teaspoon salt.
2 eggs.
3 teaspoons baking powder.

Sift together the corn meal, flour, sugar, salt, and baking powder. Add the eggs well beaten and the milk and bake one-half hour in a moderate oven.

In this case, as in the recipe for sour-milk corn bread, the corn meal can be cooked for a short time with the milk if a softer bread is desired.

This serves 8 persons.

CORN-MEAL PUFFS, GRIDDLECAKES, AND WAFFLES.

The peculiar granular consistency of corn meal, which is a disadvantage under some circumstances, is an advantage in making such dishes as griddlecakes and waffles, for it renders them very tender.

CORN-MEAL PUFFS.

1 pint milk.
⅓ cup corn meal.
4 tablespoons sugar.
½ teaspoon salt.
4 eggs.
Grated nutmeg (if desired).

Cook the milk and meal together 15 minutes with the salt and sugar. When cool add the eggs well beaten. Bake in cups. Serve with stewed fruit or jam.

This serves 6 persons.

CORN-MEAL FRITTERS.

By increasing the corn meal in the preceding recipe to one-half cup the batter is made stiff enough to be dropped into hot fat and fried.

This serves 6 persons.

CORN-MEAL PANCAKES.

2 cups wheat flour.
½ cup corn meal.
1½ tablespoons baking powder.
1½ teaspoons salt.
⅓ cup sugar.
1½ cups boiling water.
1¼ cups milk.
1 tablespoon melted butter.
1 egg.

Add the meal to the boiling water and boil 5 minutes; turn into a bowl, add the milk and remaining dry ingredients mixed and sifted, then the egg well beaten, and butter. Cook on a greased griddle.

This serves 6 persons.

CORN MEAL AND WHEAT WAFFLES.

1½ cups water.
½ cup white corn meal.
1½ cups milk.
3 cups wheat flour.
3 tablespoons sugar.
1¼ tablespoons baking powder.
1½ teaspoons salt.
Yolks 2 eggs.
Whites 2 eggs.
2 tablespoons melted butter.

Cook the meal in boiling water 20 minutes; add the milk, dry ingredients mixed and sifted, yolks of eggs well beaten, butter, and whites of eggs beaten stiff. Cook on a greased waffle iron. These waffles are often considered by most persons better than those made with wheat flour only.

This serves 6 persons.

CORN MEAL AND RICE WAFFLES.

½ cup corn meal.
½ cup wheat flour.
1 cup boiled rice.
2 eggs well beaten.
1 tablespoon melted butter.
½ teaspoon soda.
1 teaspoon salt.
1 cup sour milk.

Sift together the flour, soda, and salt. Add the other ingredients and beat thoroughly.

This serves 6 persons.

BUTTERMILK WAFFLES.

3 cups water.
2 cups corn meal.
2 cups wheat flour.
1 cup sweet milk.
4 eggs.
2 tablespoons butter.
2 teaspoons salt.
1½ teaspoons soda.
Buttermilk or sour milk enough to make a thin batter.

Cook the meal, water, salt, and butter together in a double boiler for 10 minutes. When the mush is cool add the eggs, beaten separately until very light. Sift the flour and soda together. Add the flour and the sweet milk alternately to the corn mixture. Finally add the buttermilk. This mixture is improved by standing a short time.

This serves 10 persons.

CORN MEAL AND MEAT DISHES.

A number of dishes are made of meat or fish in which corn meal mush is used, or which resemble mush in some particulars. Recipes for such dishes follow:

CORN-MEAL MUSH WITH PORK.

1 pound lean pork, part meat and part bone.
1 cup corn meal.
1 teaspoon salt.
½ teaspoon powdered sage.
Water.

Cook the pork in water until the meat can be removed easily from the bone. Remove the meat, cool the broth, and remove the fat. Reduce the broth to about a quart, or add water enough to bring it up to this amount, and cook the corn meal in it. Add the meat finely chopped and the seasonings. Pack in granite bread tins. Cut into slices and fry. Beef may be used in the same way.

This serves 6 persons.

SCRAPPLE.

Scrapple is similar to the preceding dish except that it is usually made from the head and sometimes the liver and heart of the hog. The Bureau of Animal Industry gives the following directions:

0 pounds whole hog heads.
2½ pounds hog livers and hearts.
A small quantity of beef, if desired.
pounds corn meal, yellow or mixed.
pound salt.
½ pound buckwheat or rye flour.
3 ounces spices, including pepper, sage, marjoram, and thyme in any desired proportions.

Clean the heads thoroughly, removing the eyes and ear tubes. Split the head lengthwise and remove the teeth and the soft bones in and near the nasal cavities. Place the heads and other meat in a large kettle with a liberal quantity of water and cook until the meat falls off the bones. Separate the meat and soft tissue from the bones and pass through a meat grinder. Strain he liquid in which the meat was cooked to remove the small pieces of bone, eturn to the kettle and heat to the boiling point. Then slowly add the meal nd flour, stirring constantly. Boil and stir until the mass becomes thick. Add the salt, spices, and chopped meat, and boil 10 minutes longer. Pour while still hot into deep wet molds; bread pans will do. Pour 2 to 4 tablespoons of melted lard over the material in the pans.

The scrapple is ready for use as soon as it has cooled. To prepare it for he table it is usually cut into slices about one-half inch thick, dusted with our, cracker dust, or dry corn meal, fried until the outside is crisp, and erved hot. Fried apples are good with fried scrapple.

ROAST PORK WITH BATTER PUDDING.

A dish corresponding to the Yorkshire pudding which is frequently served with roast beef can be made out of corn meal to serve with roast pork.

cup corn meal.
cup milk.
½ teaspoon salt.
2 eggs.

Place the milk, corn meal, and salt in the top of a double boiler and cook bout 10 minutes, or until the meal has expanded to form a mixture. After the mixture has cooled, add the eggs, well beaten. Grease gem tins thoroughly, allowing to each about 1 teaspoon of fat from the roast pork. Bake in a moderate oven, basting occasionally with the drippings of the pork.

This serves 4 persons.

CORN-MEAL FISH BALLS.

2 cups cold white corn-meal mush.
1 cup shredded codfish.
1 egg.
1 tablespoon butter.

Pick over the codfish and soak it to remove salt, if necessary. Combine the ingredients and drop by spoonfuls into hot fat. Drain on porous paper. These codfish balls compare very favorably in taste with those made with potato and are prepared more easily and quickly. The mush must be as dry as possible.

This makes 12 fish balls.

CORN-MEAL PUDDINGS AND CAKES.

INDIAN PUDDING.

5 cups milk.
⅓ cup corn meal.
½ cup molasses.
1 teaspoon salt.
1 teaspoon ginger.

Cook milk and meal in a double boiler 20 minutes; add molasses, salt, and ginger; pour into buttered pudding dish and bake 2 hours in slow oven; serve with cream.

This serves 8 persons.

CORN-MEAL AND FIG PUDDING.

1 cup corn meal.
1 cup molasses.
6 cups milk (or 4 cups of milk and 2 cups of cream).
1 cup finely chopped figs.
2 eggs.
1 teaspoon salt.

Cook the corn meal with 4 cups of milk, add the molasses, figs, and salt. When the mixture is cool, add the eggs well beaten. Pour into a buttered pudding dish and bake in a moderate oven for 3 hours or more. When partly cooked add the remainder of the milk or the cream without stirring the pudding.

This serves 8 or 10 persons.

CORN-MEAL AND APPLE PUDDING.

For the figs in the preceding recipe substitute a pint of finely sliced or chopped sweet apples.

This serves 8 or 10 persons.

INDIAN-MEAL DOUGHNUTS.

¾ cup milk.
1¼ cups very fine white corn meal.
1½ cups wheat flour.
¼ cup butter.
¾ cup sugar.
2 eggs well beaten.
1 teaspoon cinnamon.
2 teaspoons baking powder.
1 level teaspoon salt.

Put the milk and meal into a double boiler and heat together for about 10 minutes. Add the butter and sugar to the meal. Sift together the wheat flour, baking powder, cinnamon, and salt. Add these and the eggs to the meal. Roll out on a well-floured board, cut into the desired shapes, fry in deep fat, drain, and roll in powdered sugar.

This makes 30 medium-sized doughnuts.

MOLASSES CORN CAKE.

2 cups yellow corn meal.
½ cup molasses.
½ cup sugar.
2 tablespoons butter.
1 teaspoon salt.
1 cup sour milk.
1½ cups sweet milk.
1 cup wheat flour.
1½ teaspoons soda.
1 egg.

Mix the first seven ingredients in a double boiler and cook over hot water. Cook for about 25 minutes after the mixture has become hot. After it has cooled add the wheat flour and soda, thoroughly sifted together, and the egg well beaten. Bake in a shallow tin.

This serves 6 persons.

CORN-MEAL GINGERBREAD.

To the preceding recipe add 1½ teaspoons ginger, 1½ teaspoons cinnamon, and ½ teaspoon cloves, sifting them with the flour.

This serves 6 persons.

FRUIT GEMS.

½ cup corn meal.
1 cup wheat flour.
3 teaspoons baking powder.
6 tablespoons sugar.
2 tablespoons melted butter.
1 teaspoon salt.
1 cup milk.
1 cup raisins or currants.
2 eggs.
1 tablespoon flour reserved for flouring currants or raisins.

Mix and sift the dry ingredients; add the milk gradually, the eggs well beaten, melted butter, and raisins, which have been floured. Bake in a hot oven in buttered gem pans 25 minutes.

This makes 12 cakes.

CORN FLOUR.

Corn flour is corn meal ground and bolted until it is as fine as wheat flour. It is used in considerable quantities by bakers and as a "binder" in sausage making. During the war it was widely sold as a wheat-flour substitute for use in quick breads, cakes, and general cooking, but it is not ordinarily found on the retail market.

Some of the pancake flours on the market contain corn flour or fine corn meal, usually mixed with flour made of wheat, rye, barley, or other cereals. They may also contain baking powder and sometimes a little salt and sugar, and can be made ready for the griddle merely by mixing with liquid as directed on the wrapper.

In England the term "corn flour" refers to the separated starch which in this country is called cornstarch (see p. 3) and which is used for thickening sauces and puddings.

HOMINY.

There are several kinds of hominy on the market, but for the most part they differ more in the fineness to which they are ground than in their food value. The names by which the different kinds are known often vary with the locality, so that it is sometimes hard to tell which is referred to.

To prepare hominy by modern methods the grain is soaked enough to soften it somewhat. It is passed through a machine called a degerminator, which breaks the grain into coarse pieces and also loosens the bran and germ, which are sifted out. The coarsely broken endosperm then is dried and sold as hominy. When left in fairly large pieces it is often known as samp or pearl hominy; when ground to a very coarse meal it is called hominy grits. Any kind of hominy may be used like rice, in place of a vegetable or for a breakfast cereal. The hominy grits may also be used in puddings and cakes.

Lye hominy, or hulled corn, is a special preparation made by soaking the whole grain in water that contains lye, or sometimes merely a bag of wood ashes, until the hulls are loosened or softened, then washing the hulled grains in clear water and boiling. Lye hominy may be made at home (see p. 19) or it may be bought either in bulk or canned. It has a distinctive flavor which many enjoy and is used in the same ways as other coarse hominy.

The recipes that follow suggest a few of the ways in which hominy may be prepared.

BOILED COARSE HOMINY OR SAMP.

This kind of hominy requires long cooking. It may be prepared in a fireless cooker or in a double boiler on the back of the stove. It is wise to cook a large quantity at once, as it does not spoil easily if kept in a cool place.

Soak 1 cup coarse hominy in 2 cups water for 6 hours or overnight. If a fireless cooker with a radiator is used, add 6 cups boiling water and 3 teaspoons salt to the soaked hominy and boil over the fire for 10 minutes, put in the cooker and let it remain there for 8 to 12 hours. If there is no radiator in the cooker, the hominy should be cooked over the fire for 45 minutes, and it may be necessary to reheat the hominy and put it back in the cooker the second time.

If the hominy is cooked in a double boiler more water may be needed, or a cup of milk may be stirred in about 15 minutes before removing from the fire. It takes 5 or 6 hours to cook the coarse hominy in a double boiler and about 2 hours directly over the fire.

When used in place of a vegetable the coarse hominy may be served plain or browned in a little fat.

HOMINY TURNOVER.

1 pint cooked coarse hominy.
1 cup milk.
1 teaspoon salt.
2 well-beaten eggs.
1 tablespoon fat.

Mix all together. Turn into a frying pan in which the fat has been melted. Stir until hot throughout. Let it cook until golden brown on the bottom, then fold like an omelet and serve on a hot platter. This is suitable for the main dish at supper or luncheon.

SCALLOPED HOMINY.

Arrange in a baking dish alternate layers of boiled coarse hominy and minced meat or fish or grated cheese. Pour over all a cup of white sauce and bake for 30 minutes. This may be used as the principal part of the meat course.

HOMINY AND BEAN CAKES.

1 cup boiled coarse hominy.
1 cup cooked red kidney beans.
½ teaspoon cayenne pepper.
½ tablespoon cornstarch.
½ cup milk.
1 tablespoon fat.
1 teaspoon salt.

Make a white sauce from the last five ingredients by melting the fat, blending it with the cornstarch, salt, and pepper, adding the milk, and cooking until thickened. Grind the hominy and beans through a food chopper, mix with the white sauce, form into cakes, and brown in a little fat. Such cakes may take the place of meat occasionally.

BOILED HOMINY GRITS.

1 cup hominy grits.
5 cups water.
2 teaspoons salt.

Add the grits slowly to the salted boiling water. Boil 10 minutes over fire, then place in the fireless cooker and allow to remain overnight, or cook for 2 hours in a double boiler.

The grits may be poured while warm into a dish or molds, cooled, and served with fruit or preserves for a simple dessert, or they may be cooked in deep pans, sliced, and fried.

HOMINY MUFFINS.

1 cup cold boiled hominy grits.
1 cup sweet milk.
1 egg.
1¼ cups corn flour.
2 teaspoons baking powder.
½ teaspoon salt.
1 tablespoon melted fat.

Beat the milk and egg into the hominy grits, add the melted fat and dry ingredients. Mix well and bake in well-greased muffin pans for 30 minutes. This makes 12 muffins.

CORN MEAL AND HOMINY BREAD.

1 cup corn meal.
1 cup boiled hominy grits.
1 cup milk.
1 egg.
1 tablespoon melted fat.
1 teaspoon baking powder.
½ teaspoon salt.

Beat the milk and egg into the hominy grits, add the melted fat and dry ingredients, and mix well.

This batter may be baked in a greased pan and served with a spoon from the dish in which it is baked as a spoon bread, or it may be cooked on a griddle and served as griddle cakes.

HOMINY DATE PUDDING.

1 cup hominy grits.
5 cups milk (skim or whole).
1 teaspoon salt.
¼ cup sugar.
1 cup chopped seeded dates.
1 teaspoon vanilla.

Add the salt and hominy grits to the milk and cook in a double boiler one hour. Add sweetening, dates, and vanilla, and mix well. Partially cool before serving.

FRUIT SCALLOP.

1½ cups cooked hominy grits.
1 cup stewed apricots.
¼ cup apricot juice.
1 tablespoon sugar.
½ tablespoon butter.

Into a greased baking dish place first a layer of the hominy grits which have been mixed with the fruit juice, then a layer of the fruit. Repeat until dish is nearly full. Dot over with the butter and sprinkle with 1 tablespoon of sugar mixed with cinnamon. Bake until brown. Serve hot or cold with sauce or top milk.

Peaches, pears, and other fruits may be used instead of apricots.

LYE HOMINY OR HULLED CORN.

This is easily made at home from any variety of white or yellow dent or flint corn. The kinds with fairly large kernels are easier to hull than those with small kernels, and only clean, sound ears should be used.

The hulls and germs are loosened by steeping the corn in a lye solution, rubbing off the hulls, then washing out the lye, and finally boiling the corn. Sometimes the kernels are boiled with the lye, but cold soaking is also efficacious and gives what many consider a more delicate flavor. The Office of Cereal Investigations of the Bureau of Plant Industry recommends the following method:

Dissolve 5 ounces of lye (sodium hydroxide or caustic soda) in 6 quarts of cold water. Stir in 5 quarts of corn and let stand 15 hours. Wash thoroughly to remove the lye and the hulls; rubbing the hominy in a cloth bag helps to take off the hulls. When the washing is finished the hull and black tip should be off and the kernel should look clean. The slight discoloration which the lye causes may be removed by soaking the hominy overnight in water to which a little salt has been added. Cover with water to which 5 tablespoons of salt have been added and boil in a covered kettle for three or four hours or until thoroughly cooked, making sure that the hominy remains covered with water. Changing the water once or twice during the cooking will lessen the taste of lye. Five quarts of corn will make from 15 to 20 quarts of lye hominy.

SPECIAL BREAKFAST PREPARATIONS.

Aside from the corn meal and hominy of various kinds that are commonly used as breakfast cereals, there are on the market other preparations of corn intended for the same purpose. These are mostly already cooked and require only warming up to make them ready to serve. Most are steam cooked and roasted. Some are pressed into flakes, and others are treated by a process resembling shredding. In some cases malt and other materials are added to improve the flavor.

These goods are usually sold in cartons under trade names, and the net weight of the contents is given on the wrapper, as required by law. They are clean and often very convenient, but their price is naturally higher than that of the plain meal or hominy. Whether the variety they offer and the ease with which they can be served are worth the extra cost each housekeeper must decide according to her individual circumstances.

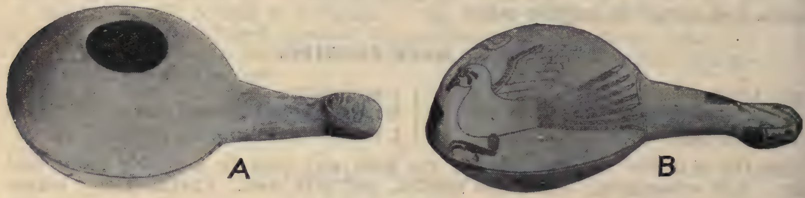

FIG. 4.—An ancient Peruvian corn popper. A, top; B, bottom.

POP CORN.

Though corn meal is now used in other parts of the world, pop corn seems still to be a peculiarly American product. White, fluffy kernels of popped corn have been found among prehistoric Indian remains in South America and also specially shaped earthenware implements (fig. 4) with a depression in the center and a long handle, evidently the equivalent of our modern corn poppers. In olden days in this country the grains were sometimes thrown on the hot coals, where they burst and bounded back on the floor for the children to scramble after. The varieties of corn best adapted for pop corn, methods of cultivation, poppers, and suggestions for making such pop-corn dainties as pop-corn balls are described in another bulletin of this series.[2]

Though pop corn is most often eaten between meals and as a sort of food accessory, it has a food value similar to that of the same weight of corn prepared in other ways. It makes an excellent breakfast cereal served with milk or cream, and is so used in many families. It is hard to imagine a better supper for a winter Sunday at home than corn popped over the open fire (fig. 5) and served hot with melted butter or with milk and a little salt, and perhaps with apples or other fruit as a finish.

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[2] U. S. Dept. Agr., Farmers' Bul. No. 553, Pop Corn for the Home.

FIG. 5.—Popcorn for supper.

The recipes which follow show how popped corn can be made into wholesome homemade sweets of which children and elders are usually very fond.

CHOCOLATE POP CORN.

2 cups of white sugar.	2 ounces of chocolate.
½ cup of corn sirup.	1 cup of water.

Put these ingredients into a kettle and cook them until the sirup hardens when put in cold water. Pour over 4 quarts of crisp, freshly popped corn and stir well to insure the uniform coating of the kernels.

SUGARED POP CORN.

Make a sirup by boiling together 2 cups of granulated sugar and 1 cup of water. Boil until the sirup strings from the spoon or hardens when dropped into cold water. Pour over 6 quarts of freshly popped corn and stir well.

POP-CORN BALLS.

1 pint of sirup.	2 tablespoonfuls of butter.
1 pint of sugar.	1 teaspoonful of vinegar.

Cook till the sirup hardens when dropped into cold water. Remove to back of stove and add one-half teaspoonful of soda dissolved in a tablespoonful of hot water and then pour the hot sirup over 4 quarts of freshly popped corn, stirring till each kernel is well coated, when the mixture can be molded into balls or into any desired form.

Maple sirup makes light-colored balls, while darker ones are made with New Orleans molasses.

FRESH, CANNED, AND DRIED GREEN CORN.

The half-ripe ears of corn make a very favorite vegetable in this country. The so-called sweet varieties, which contain more sugar and less starch than those grown primarily for making meal or hominy, are especially prized for this purpose because of their better flavor and more delicate texture, but the other varieties are sometimes used in this way.

Green corn, like many other vegetables, is at its best when freshly gathered. Corn on the cob is not very convenient to serve or eat, and this method of cooking it would doubtless have been abandoned long ago if cutting the kernels from the cob before cooking did not materially modify the flavor. The most convenient way of cooking corn on the cob is ordinarily by boiling, but in old-fashioned fireplaces roasting was a favorite method. This still survives as a common household practice in some localities and also in camp-fire cookery.

The season of fresh corn is more nearly limited to the season of maturity in a given region than that of almost any other common vegetable, for it can not be stored for any considerable time in good condition, even with modern appliances, and corn grown in warm climates and shipped long distances to our winter markets is very expensive and rather uncertain as to its quality. Corn, however, may be readily canned either at home or on a commercial scale, and when this is properly done the corn retains many of its desirable qualities. It is not surprising, therefore, to find that canned corn is one of the most popular canned vegetables.

A full discussion of the reasons for each step in the canning process and complete instructions are given in another bulletin of this series.[3]

Canned corn is used not only by itself but is also made into a variety of soups, fritters, puddings, and other dishes.

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[3] U. S. Dept. Agr., Farmers' Bul. No. 1211, Home Canning of Fruits and Vegetables.

The preservation of green corn by drying has long been practiced in the household and dried corn is to a limited extent prepared commercially. The ears of corn are first scalded for about 5 minutes, then cooled and the kernels cut from the cob. Unless the corn is very young and tender the resulting dried corn will be much more satisfactory if only the tips of the kernels are removed by the first cut and the remaining pulp scraped out with a dull knife, leaving the most of the hulls behind on the cob. Even in the case of young corn the cutting should not be so close as to include the base of the kernel.

The corn may be dried by any convenient method. Where a large quantity is being prepared it may be spread upon a table covered with muslin. Of course it must be protected from flies. The corn should be well stirred from time to time until thoroughly dry.

When wanted for use the dry corn should be rinsed quickly in cold water and put to soak for several hours in a small amount of water in which it is to be cooked. The cooking should be done slowly and water added as needed. Cooked dried corn may be used in any of the ways in which canned corn is served. Dried corn has a sweet, nutty flavor, and is especially liked for making cream of corn soup or in succotash.

Corn is sometimes combined with other vegetables. Succotash, a mixture of unripe corn and beans, is a dish borrowed, name and all, from the American Indians and has been a favorite since colonial times. To vary their winter diet, the colonists often cooked dry ripe corn and beans together, but such a dish does not possess the palatability of that made from green corn. Corn with tomatoes is another mixture which many persons like and which is quite commonly served. Directions for canning it at home are given in the bulletin referred to.[4] Small, immature ears of unripe corn are sometimes used in mixed pickles, particularly in Europe, and relishes are also made in the United States from green corn, both as a domestic article and commercially.

The following recipes show a few of the many ways of using fresh and canned corn. Fresh corn can be used in place of canned corn in any of these. Canned corn may sometimes be substituted for fresh in the recipes which specify fresh corn, but the results are not likely to be so good because the consistency of the canned corn is usually not like that of the fresh.

BOILED CORN ON THE COB.

Free the corn from husks and "silk." Have a kettle of water boiling rapidly, drop the corn into the water and cook 10 minutes. If only a few ears of corn are put in a kettle of boiling water, the temperature of the water is not lowered greatly and the corn will cook in 8 minutes. On the other hand, if a large quantity of corn is crowded into a kettle of boiling water, the temperature is very much lowered and the time of cooking must be increased. When possible, surround the corn with a generous quantity of boiling water. Be careful not to cook sweet corn too long, or it is likely to be tough and tasteless.

When corn and potatoes are to be cooked at one time, six to eight ears can be steamed in the same kettle in which the potatoes are boiled. Lay the ears over the potatoes in rapidly boiling water and cover the kettle tightly.

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[4] U. S. Dept. Agr., Farmers' Bul. No. 1211, Home Canning of Fruits and Vegetables.

CORN CUT FROM THE COB.

Corn may be cut from the cob and heated with butter, pepper, and a little milk. Use either raw corn, or, better, corn that has been cooked on the cob for 5 minutes in boiling water to set the juice. With a sharp knife cut through the center of each row of grains and with the back of a case knife press the grains of corn from the hulls. Put the corn in a saucepan and season with salt, pepper, and butter. Add enough hot milk to moisten well, and cook 10 minutes. Serve at once.

Another method, sometimes known as "Maine style," is to cut the grains directly from the cob without scoring and scraping, and to season and heat as above. This is a good way to utilize left-over cooked ears.

SUCCOTASH.

To a pint of corn cooked as above, or to the same amount of canned corn, add a pint of cooked and seasoned shelled beans.

CORN SOUP.

1 can, or 2 cups corn.
1 pint boiling water.
1 pint milk.
1 slice onion.
2 tablespoons butter.
2 tablespoons flour.
1 teaspoon salt.
Dash of pepper.
Dash of paprika.

Fry the onion in the butter and stir in the flour. If raw corn is used, place it in boiling water and boil 5 to 7 minutes. Add the milk to the corn and bring to the scalding point. Thicken with the onion, flour, and butter mixture and add the seasonings.

CORN CHOWDER.

1 cup fresh corn.
1½ inch cube salt pork, diced.
1 onion, sliced.
1 quart potatoes, sliced.
1 cup milk or cream.
Salt and pepper.
8 crackers.

Fry the salt pork, add the onion, and cook until the onion is tender. Boil the potatoes 5 minutes in 1 quart of boiling water, add the fat, and cook until the potatoes are soft. Add the corn and milk and bring to the scalding point. Add the butter and seasoning. Pour over the crackers and serve hot.

SCALLOPED CORN.

1 cup milk.
1 can, or 2 cups corn.
1 cup bread or cracker crumbs.
2 slices green pepper.
1 teaspoon salt.
⅛ teaspoon pepper.
2 tablespoons butter.

Place alternate layers of corn and bread crumbs in a greased baking dish, adding butter and seasoning to each layer. If desired, 1 tablespoon of sugar may be added. Pour on the milk and bake for one-half hour.

CORN CUSTARD OR PUDDING.

1 can, or 2 cups corn.
2 tablespoons butter.
1¼ teaspoons salt.
3 eggs.
1½ cups milk.
1 tablespoon sugar.

Mix as for a baked custard. Pour into a casserole and set in the oven in boiling water. Bake in a moderate oven (350° F.) until set, or about 1 hour and 15 minutes .

CORN FRITTERS.

4 tablespoons fresh corn.
1 teaspoon melted fat.
1 teaspoon baking powder.
1 egg.
½ cup milk.
1 cup flour.
½ teaspoon salt.

Mix to make a batter and fry in deep fat.

STUFFED GREEN PEPPERS.

6 green peppers.
2¼ cups fresh corn.
½ onion cut up fine.
1½ cups meat chopped or ground fine.
1½ cups meat stock thickened with 2 tablespoons flour.
1½ cups bread crumbs.
½ teaspoon salt.
Dash of pepper.

Remove the tops and seeds from the peppers and parboil in boiling water for 2 minutes. Remove from the water, drain, and put in a casserole. Stuff the peppers with a mixture of the corn, onion, meat, bread crumbs, thickened stock mixture, and seasoning and bake. The mixture may be varied by using other materials such as rice and tomatoes.

CORN SOUFFLÉ.

1 cup fresh corn.
1 cup white sauce (see following recipe).
3 eggs.
½ teaspoon salt.
Dash pepper.

Add the well-beaten egg yolks to the sauce and fold in the corn. Fold in the stiffly beaten egg whites and place in a buttered baking dish, set the dish in a pan of hot water, and bake in a moderate oven (350° F.) 30 to 40 minutes.

WHITE SAUCE FOR SOUFFLÉ.

1 cup milk.
3 tablespoons flour.
½ tablespoon salt.
2 tablespoons butter.

Melt the butter and stir in the flour and salt. Add the scalded milk and stir until the mixture thickens and the flour is cooked. The white sauce may be made in a double boiler or directly over the flame. If the latter method is used, care must be taken that the product is not scorched.

SUMMARY.

Corn is one of the most important cereal foods in the United States, and is in more general use in the Southern than in the Northern States.

Its food value is very similar to that of the other cereals. When used in a diet that also supplies dairy products, flesh foods, and vegetables or fruits, the choice between the various cereals depends more on personal preference and price than on the nourishment supplied. If corn is abundant and cheap, or if wheat, rice, or other cereals are scarce or dear, corn may safely be substituted for them.

Corn preparations may be used in place of starchy vegetables such as potatoes, sweet potatoes, or beans, but in such cases some other vegetable or fruit should also be included in the diet to supply the mineral matters and vitamins which are less abundant or lacking in the corn.

Corn can be substituted for part of the wheat in making yeast-raised bread, but not for all because it does not contain the necessary gluten. It can also be used in place of part or all of the wheat flour in many good quick breads and cakes.

The amount of the germ and skin removed when corn is milled affects its food value as well as its appearance, flavor, and keeping quality. When the germ is removed most of the fat and all of vitamin A usually go with it. When the skin is removed the meal contains less cellulose and a little less protein, mineral substances, and vitamin B.

"Old-process" corn meal is ground by stones, and contains most of the germ and usually more or less of the skin. It therefore includes nearly all of the protein, fat, mineral matters, cellulose, and vitamins, as well as the starch of the grain. Such meal feels soft and flourlike to the touch, has a flavor that many consider superior, but does not keep indefinitely. It is usually ground by local mills for quick consumption, and is more commonly used in the South.

"New-process" corn meal is ground by steel rollers or disks. Most of the germ and skin have been removed in preparing it, so that it usually contains somewhat less protein and considerably less fat, mineral matters, cellulose, and vitamins than "old-process" meal. It feels granular to the touch and keeps well.

Corn meal is boiled to make mush or porridge, which may be served as a breakfast cereal, in the place of a starchy vegetable, and in various other ways. The meal also forms the basis of many quick breads, cakes, and puddings, and is combined with milk, cheese, eggs, meat, or other foods into nutritious and wholesome dishes which may be served as the main dish at a meal.

Hominy, coarse hominy, samp, and hominy grits are names for preparations in which the corn kernel is split more or less finely.

Lye hominy or hulled corn is made by soaking the whole kernels in a lye solution to loosen the hulls, then washing the corn and boiling in water.

All kinds of hominy are used as a breakfast cereal, in place of starchy vegetables, and in a variety of cakes, puddings, and dishes made with meat, fish, or cheese.

Pop corn is made from special varieties of corn, the dried kernels of which burst open when quickly heated. A pound of popped corn has practically the same food value as a pound of dry corn meal or hominy.

Partly ripened or green corn, especially certain sweet varieties, is a favorite vegetable in this country. It is in common use both fresh and canned and is occasionally preserved by drying.

Ceremonial censer used by the Aztec Indians.

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Farmers Bulletin 1237
United States Department of Agriculture

PINEAPPLE CULTURE IN FLORIDA

THIS BULLETIN discusses the history of pineapple growing in Florida, the usual methods of culture, the causes for the recent decline of the industry, and the most promising methods for its restoration.

This once thriving industry has rapidly declined in recent years. Most of the fields have been abandoned and pineapple growing in Florida is now threatened with extinction. The chief causes are the depletion of soil humus and fertility through constant cultivation and exposure to the tropical sun, the growing prevalence of wilt due to attacks of nematodes, and failure to use healthy, vigorous slips in new plantings.

As a practical method of restoring abandoned fields, it is recommended that Natal grass be sown and allowed to grow on the impoverished soil for two years or longer. This practically starves out the nematodes, as Natal grass is immune, or nearly so, to them, and at the same time adds the essential humus to the soil. Carefully selected and vigorous slips should then be planted. Whenever pineapples begin to show a decrease in production the land should again be rotated to Natal grass.

By the use of the methods suggested, which are based upon experimental planting made by the Bureau of Plant Industry, it is believed that pineapple growing eventually can be reestablished, not only in Florida, but in other sections where similar conditions exist.

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief

Washington, D. C.
Issued November, 1921

PINEAPPLE CULTURE IN FLORIDA.[1]

By E. D. Vosbury, formerly *Scientific Assistant, Office of Horticultural and Pomological Investigations*, and J. R. Winston, *Pathologist, Office of Fruit-Disease Investigations.*

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GEOGRAPHIC DISTRIBUTION OF PINEAPPLE CULTURE.

THE PINEAPPLE, universally considered one of the finest of all fruits, is widely cultivated throughout the tropical regions of the world. Large quantities of the fresh fruit are annually imported into the United States from the West Indies (including Porto Rico), and from the Hawaiian Islands still larger shipments of the canned article are received.

A native of tropical South America, the pineapple is so easily injured by cold that its culture in the United States is restricted to the regions of southern Florida most nearly frost free. Small plantings have been started from time to time in California and in southeastern Texas, but these have been abandoned on account of adverse climatic or other conditions.

HISTORY OF THE FLORIDA PINEAPPLE INDUSTRY.

The earliest recorded successful planting of pineapples in Florida was made in 1860, when Benjamin Baker, of Key West, obtained a number of slips from Havana and started a small experimental patch on Plantation Key.[2] The venture was so successful and the profits realized were so excellent that a rapid growth of the industry on the keys resulted. (Fig. 1, *B*.) The shallow soils of the keys soon became exhausted, and most of the plantations there were abandoned. In the meanwhile the industry had spread to other parts of Florida where pineapple culture met with varying success. A number of plantings under sheds were made in Lake, Orange, Volusia, and other interior counties, but with few exceptions these were soon abandoned. By 1890 the industry had become centralized in the famous east-coast pineapple belt, extending from the vicinity of Fort Pierce southward to Miami (fig. 1, *A*).

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[1] The writers are indebted to C. D. Sherbakoff, pathologist, Florida Agricultural Experiment Station; R. L. Goodwin, A. W. Hoofnagle, and T. C. Heoflich, Fort Pierce, Fla.; C. Dunscombe, Stuart, Fla.; T. V. Moore, Miami, Fla.; and other pineapple growers and investigators for valuable suggestions and assistance.

[2] Report on the condition of tropical and semitropical fruits in the United States in 1887. U. S. Dept. Agr., Div. Pomol. Bul. 1, 149 p., 3 col. pl. 1888.

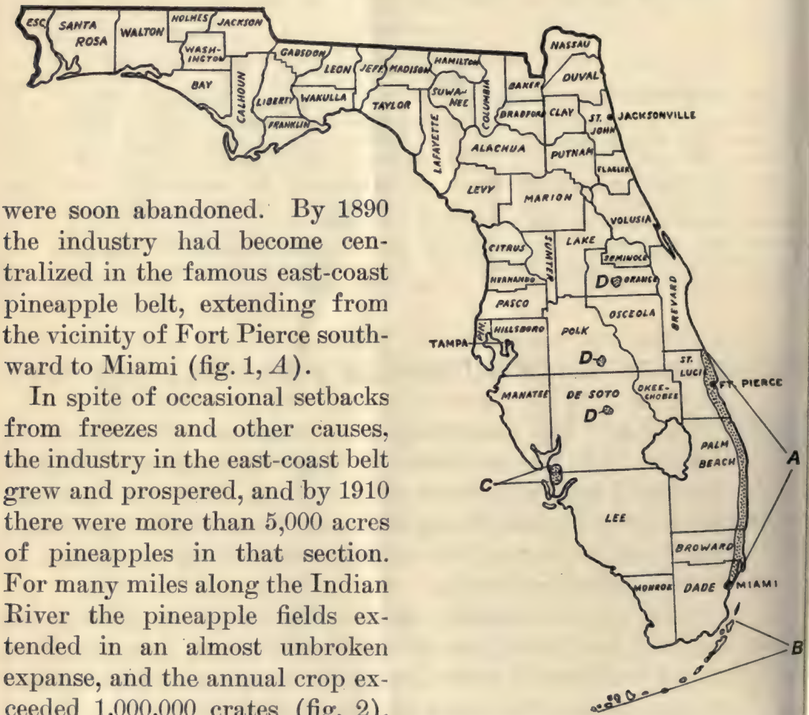

FIG. 1.—Dotted areas indicate the princip pineapple-growing sections: *A*, East-coa belt; *B*, keys section; *C*, Punta Gord section; *D*, old region of scattered plan ings under sheds.

In spite of occasional setbacks from freezes and other causes, the industry in the east-coast belt grew and prospered, and by 1910 there were more than 5,000 acres of pineapples in that section. For many miles along the Indian River the pineapple fields extended in an almost unbroken expanse, and the annual crop exceeded 1,000,000 crates (fig. 2). At about that time, however, serious crop shortages began to occur in some of the older plantings, where the plants commenced to show loss in vigor and decreasing yields. This declin became more and more prevalent, until by 1917 many of the field had been permanently abandoned or neglected (fig. 3). A heav freeze which swept over the State in February, 1917, and a secon freeze in the fall of that year were final blows to many growers. I 1920 there were only a few hundred acres of bearing pineapples i Florida. But few new plantings had been made since the freeze c 1917, owing to the scarcity of slips and to the belief of the growe that the suitable pineapple soils were exhausted.

Near Punta Gorda, on the western coast of the State, about 60 acres of pineapples were grown with shed protection in 1915 (fig. 1, *C*). Fruit of choice quality was produced, and the industry there was considered quite promising. As on the east coast, however, these plantings have largely died out during the past few years, and in 1920 only 2 or 3 acres remained (fig. 4).

The failure of the pineapple industry of Florida is a particularly serious matter to the farmers of these localities, as much of the land on which this fruit has been grown is too light and sandy for the profitable production of other crops. The demand for reliable information regarding the profitable restoration of the abandoned ields is therefore urgent.

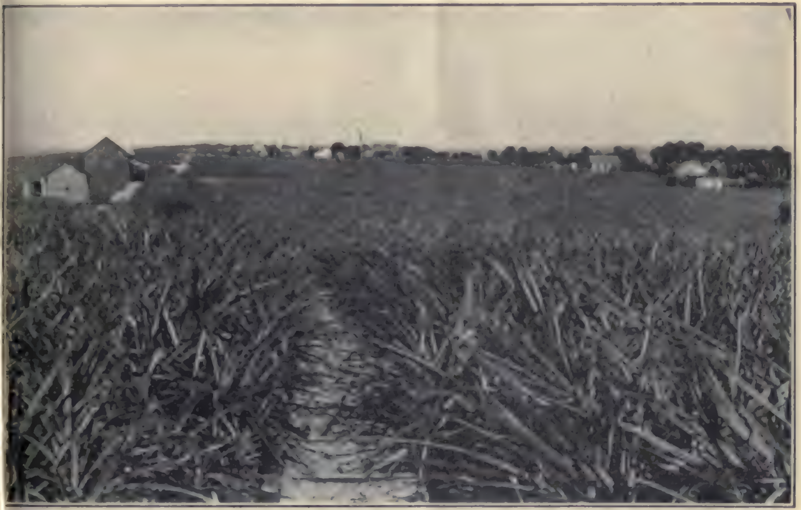

FIG. 2.—Part of the east-coast pineapple belt, near Jensen, Fla., showing the elevation of the land above the surrounding country, with marshes at the left and the Indian River at the right.

SELECTING A LOCALITY AND SITE FOR THE PINEAPPLE PLANTATION.

SELECTING A GENERAL LOCALITY.

As pineapples are injured by temperatures lower than 30° F., a ocality for their culture should be selected which is practically free rom severe freezes. Nearly all plantings in Florida have been made n the southern portion of the State. It should be understood, however, that though general climatic conditions become more tropical as ne proceeds southward, latitude alone does not determine the danger from freezes. Damage from cold is often greater in southern ocalities than in latitudes farther north, and the topography and surroundings of a locality influence its liability to freezes and its suitability for tropical fruit culture. The effects of local climatic conditions are illustrated in the leading pineapple sections of Florida.

The earliest plantings were made on the coastal islands, or keys (fig. 1, *B*), in the extreme southern part of the State, which are surrounded and protected by large bodies of salt water. The famous east-coast pineapple belt (fig. 1, *A*) consists of a narrow ridge, an ancient sand dune, 1 to 3 miles wide and about 150 miles long, which is elevated some 25 to 50 feet above the surrounding country. It is bounded on the east by the waters of the Indian River and the Atlantic Ocean and on the west by marshes known locally as "savannahs" (see figs. 2 and 24). The elevation of this ridge above the surrounding country adds greatly to its freedom from frost, as the cold air drains to the lower levels. The large bodies of water on either side of the ridge also furnish further protection from cold.

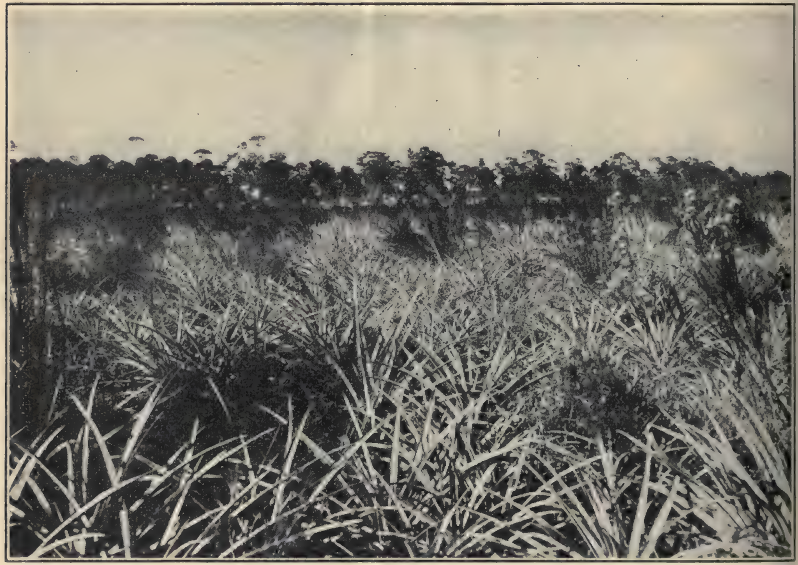

FIG. 3.—An abandoned pineapple field.

SELECTING A PARTICULAR SITE.

After a favorable general locality has been decided on, consideration should be given to the selection of a desirable site within that region. The choice must be made with great care, as very frequently desirable and unsuitable sites are found in close proximity. Careful consideration should be given to the questions of local air drainage and water protection and their influence on potential damage from cold. The factor of roads should also be taken into account, as pineapples are injured by long hauls over rough roads, and, besides, such hauls are expensive. A field should be selected, therefore, as near as possible to a good shipping point (fig. 5). Among other points which should be considered in selecting a site are community advantages, an adequate supply of labor, and marketing facilities.

Many of the conditions for successful pineapple growing will be unfamiliar to growers who may have been successful with other fruits. The mistake of choosing an unsuitable site for a pineapple plantation, as in the case of other kinds of fruit growing, is likely to prove extremely costly and is usually without remedy. The newcomer, especially when his capital is limited, should proceed with great caution and purchase land only after thorough investigation and after consultation with successful growers.

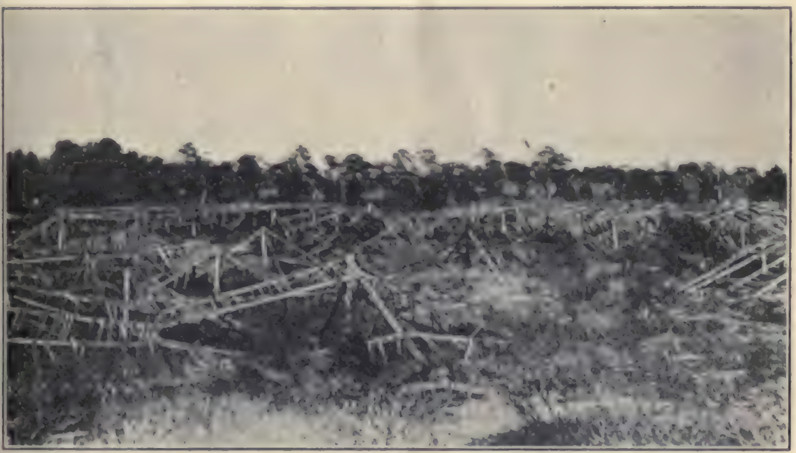

FIG. 4.—An abandoned shed pineapple plantation.

SOILS FOR PINEAPPLES.

Pineapples require an open, thoroughly drained soil. Nearly all of the Florida plantings have been made on light sandy soils, too low in fertility for most crops but adapted for pineapples when properly fertilized and supplied with humus. The maintenance of a sufficient supply of humus in pineapple growing, as in the culture of other crops, is essential in order to increase the beneficial activity of soil organisms, to promote the general fertility of the soil, and to improve its physical condition. Most Florida pineapple soils in their original state are poorly supplied with humus, and one of the essential measures that must be taken in building up the Florida pineapple industry, as will be shown later in considering humus depletion, is that of maintaining and increasing the humus supply.

Most of the fields of the east-coast belt have been planted on scrub-pine land which bears an original growth of scrub-pine[3] trees. The soil of this type is a white sand underlain at a depth of 5 feet or more with a subsoil of yellow sand. A somewhat more limited soil type is that known as "hickory scrub," which supports a native growth of hickories, oaks, and other hardwood trees. It is underlain at a depth of 5 to 10 inches with the same yellow sand subsoil found at a much greater depth in the scrub-pine land. The soil of the "hickory scrub" land is somewhat finer in texture, richer in humus. and more retentive of fertility than the scrub-pine land. It is the soil type preferred by most experienced Florida growers. The hammock type of land (fig. 6) in a virgin state is characterized by a growth of cabbage palmettos and live oaks. This type is the richest in fertility and humus of any of the soils commonly used for pineapples. It is also well adapted for vegetables and other crops, but is only found in small tracts in the pineapple-growing sections. The high pineland is considered satisfactory for pineapples, but is found only to a very limited extent in Florida regions where climatic conditions permit the growing of pineapples in the open. Flatwoods pineland, found particularly in the vicinity of Miami and Punta Gorda, is also satisfactory when provided with natural or artificial drainage (fig. 7).

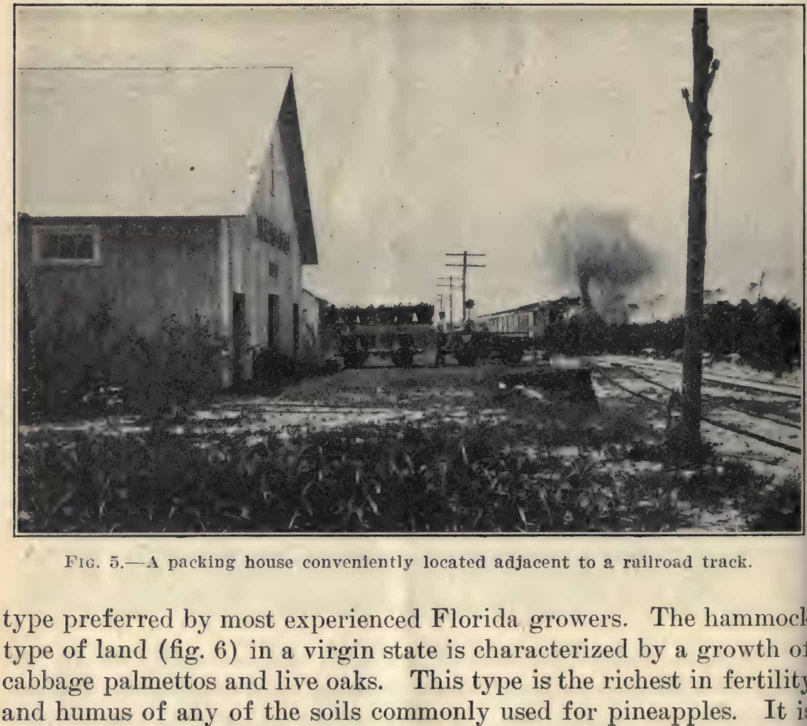

FIG. 5.—A packing house conveniently located adjacent to a railroad track.

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[3] *Pinus clausa.*

PINEAPPLE VARIETIES FOR FLORIDA.

A large number of pineapple varieties have been introduced into Florida from time to time, many of them being still found in home gardens and experimental plantings. Only two or three varieties are grown on a commercial scale.

The Spanish (*Red Spanish*) variety, spoken of as the "common" pineapple, is by far the most widely cultivated, constituting more than 90 per cent of the total plantings (fig. 8). The plants are hardier than those of the other common varieties and easier to grow. They are easily propagated from slips, which are abundantly produced (fig. 9). The fruits of this variety are of medium size and possess excellent shipping quality when carefully handled, but their dessert quality, while good, is inferior to that of other varieties grown.

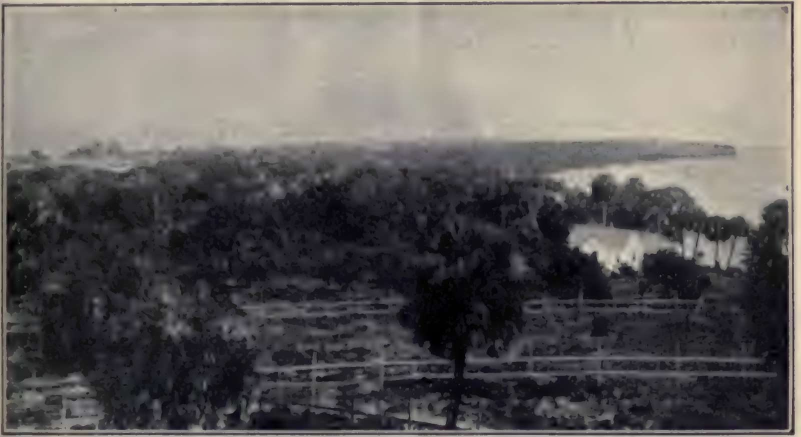

FIG. 6.—Hammock land on the border of the Indian River.

The only other pineapple variety grown in Florida to any important extent is the Cayenne (*Smooth Cayenne*). The plants of this variety are large, with broad leaves, free from spines. The fruits are larger and have higher dessert quality, but are more tender, more easily injured, and require much more care in handling and shipping than those of the Spanish variety. The Cayenne is propagated chiefly from suckers, as few slips are produced. The scarcity of slips is a serious drawback when rapid propagation is desired, as but one or two suckers can be taken from a plant. The Cayenne is he principal variety canned in Hawaii.

The Abachi (*Abakka*) variety is grown to a very limited extent in one or two localities. The fruits are of large size and of excellent dessert quality (fig. 10), but they are tender and must be carefully handled in harvesting and shipping.

A serious fault of the Abachi variety is that the slips are often attached so closely to the base of the fruit that it is difficult to separate them without injury to the fruit.

For the average grower in Florida the hardy and easily grown Spanish is probably the best variety to plant. The grower who desires to develop a special market for fancy fruit and who is prepared to give his crop the most skillful and painstaking attention will usually prefer the Cayenne or the Abachi variety.

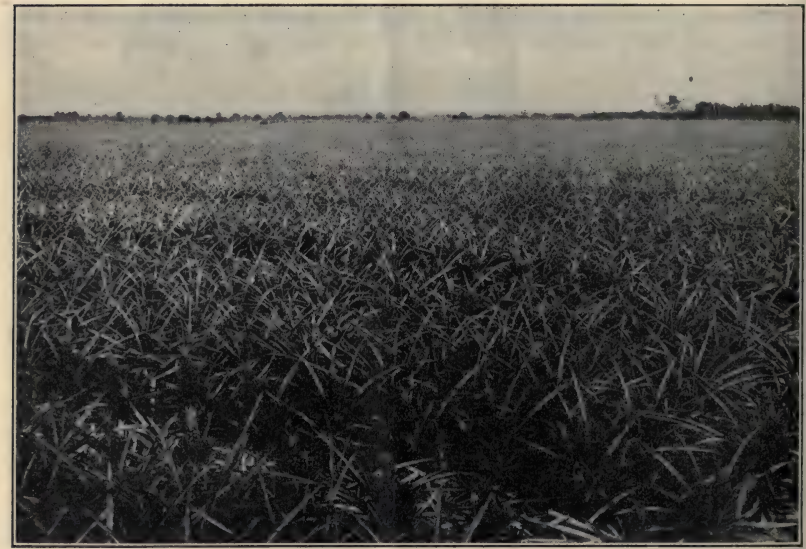

FIG. 7.—A pineapple plantation on flatwoods pineland.

PROPAGATION.

SUCKERS, RATOONS, AND SLIPS.

After fruiting, the central portion of the plant gradually dies back toward the base. Before the fruit is mature, however, suckers begin to develop in the axils of the leaves above ground and other suckers, called ratoons, also develop from points along the stem below the surface of the ground. These ratoons take root directly in the soil, while the suckers which develop from the axils of the leaves are nourished first through the base of the parent plant and later by aerial root systems which eventually take root in the ground. The plant growths from buds on the fruit stalk near the base of the fruit are known as "slips," while the tuftlike growth at the top o the fruit is called a "crown." Slips appearing at the apex of the fruit just below the crown are called "crown slips" (fig. 11).

The pineapple occasionally produces seeds. These, however, do not reproduce the variety. They are rarely used, except for experimental purposes. Several years are required to produce a mature plant from a seed.

Propagation is usually accomplished by means of slips or suckers, although crowns and other vegetative parts of the plants are sometimes used. The Spanish variety is commonly propagated from slips, which are produced at the average rate of five or six to the plant. The Cayenne variety produces an average of less than one to the plant and is commonly propagated both from slips and suckers. The Abachi variety is usually propagated by means of slips, which are abundantly produced.

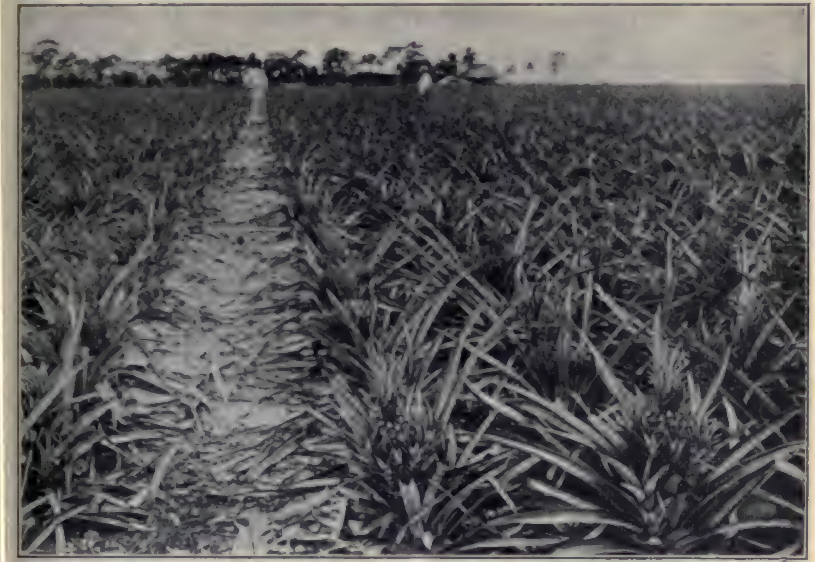

FIG. 8.—A field of Spanish (*Red Spanish*) pineapples on flatwoods land.

The ratoons are generally left in place to perpetuate the plantation. As they develop they take the place of the former fruit-bearing stalk. The suckers, unless removed, normally take root and also form new fruiting plants. After they have produced fruit they in turn give way to other ratoons or basal suckers. The number of ratoons a plant may develop varies, as does the number of slips and suckers. Two ratoons to each plant are desirable for perpetuating a plantation. If surplus ratoons develop, they may be removed and used, as are slips and suckers, for other plantings.

COLLECTING AND PREPARING SUCKERS AND SLIPS.

The same methods are used in the collection and preparation of both suckers and slips. Although planting may be successful at any season, it is usually done in August and September. Most growe prefer to set their slips before the middle of September, in order

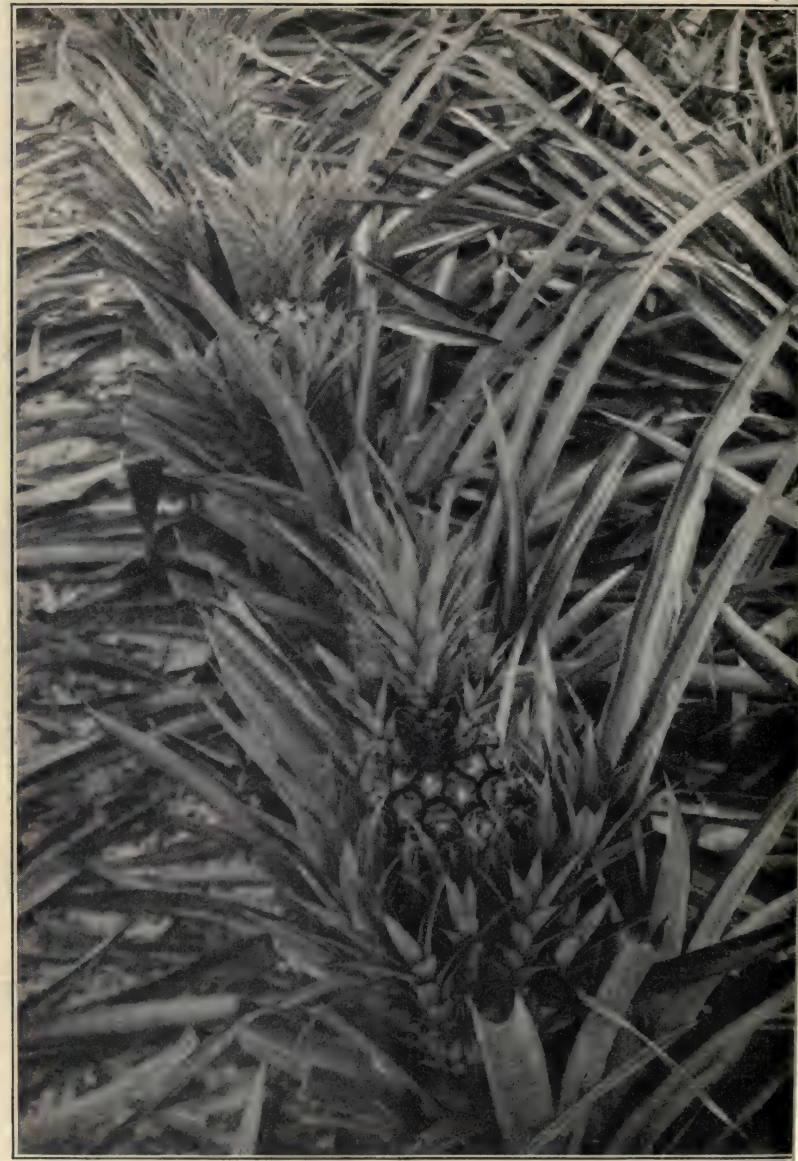

FIG. 9.—The Spanish (*Red Spanish*) fruit and slips.

secure the advantages of the summer rainy season. From eight to twelve thousand suckers or slips are required to plant an acre.

Suckers and slips are removed from the parent plant after they reach full maturity, which is indicated by the brown color of the stem of the sucker or slip. In collecting these, laborers proceed through the fields, break them off and throw them into the aisles, to be collected into piles. The material is then trimmed (fig. 12) by cutting off the hard basal end and stripping off the lower eaves, a process which sometimes facilitates its rooting when planted in dry soils. Some growers ure their suckers and slips by exposing them to the sun for a week or two before planting, but while this process is supposed to make the plants more disease resistant, there is little vidence to show that ny benefit is derived hereby.

Fig. 10.—A tempting slice of an Abachi (*Abakka*) pineapple.

Planting may be one at any time within two or three weeks after the suckers or slips are gathered. Slips are usu- lly set 2 to 4 inches eep and suckers from 3 to 5 inches deep, according to size. In set- ng (fig. 13), a small hole is made in the soil with the fingers or ith a dibble, a slip is inserted, and the soil then firmed about it so hat the bud is about 1 inch above the surface of the ground.

SELECTION OF SUCKERS AND SLIPS.

In gathering suckers or slips for planting, few growers pay any attention to the quality or condition of the parent plant or to the desirability of the fruit which it bears. All suckers and slips convenient size for planting usually are collected, and when they a scarce even the smallest and scrubbiest, including those from wea

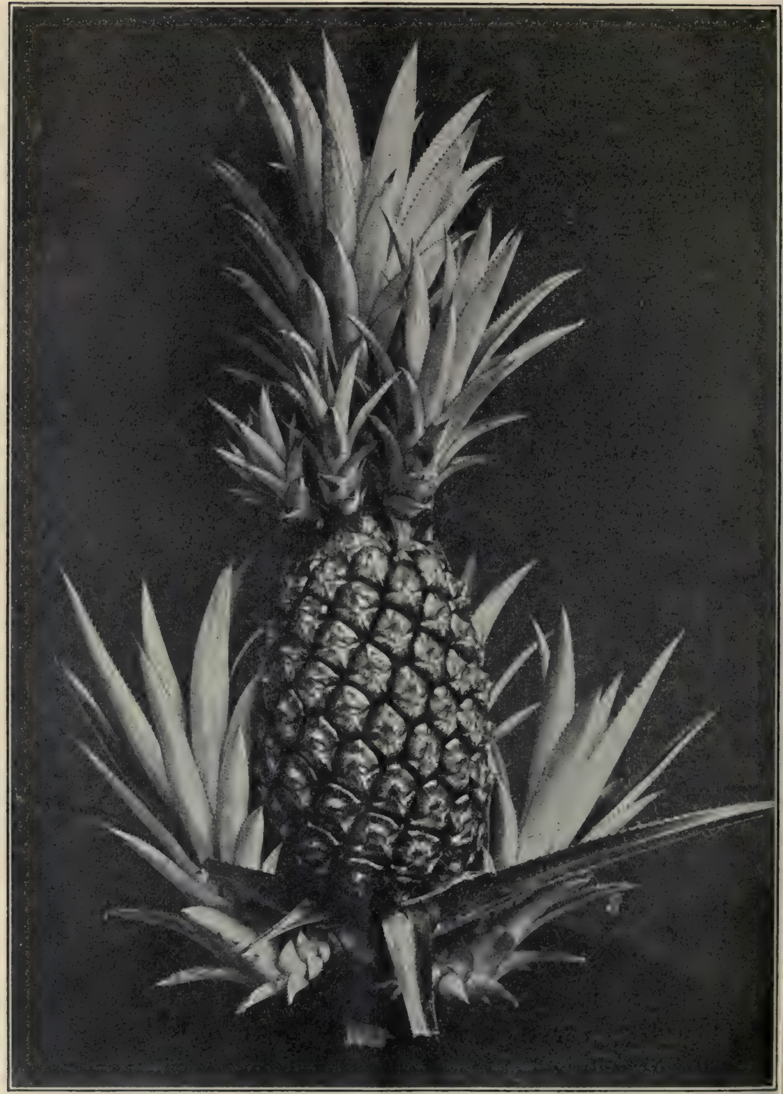

FIG. 11.—A pineapple of the Abachi (*Abakka*) variety, showing basal slips, crown slips and crown.

or diseased plants or from plants bearing small, misshapen fruits, are gathered and planted. As a result of this indiscriminate planting, many undesirable types of plants and fruits are perpetuated. Moreover, it is probable that communicable diseases are frequently transmitted from unhealthy parent plants to new fields.

Trial plantings made by the Bureau of Plant Industry of the United States Department of Agriculture and investigations made throughout the Florida pineapple sections have shown emphatically that more care in selecting propagating material is essential. It has been found that large slips and suckers selected from healthy, vigorous plants not only produce much stronger plants but they are more free from disease. Furthermore, they come into bearing from 12 to 24 months sooner than weak or diseased plants (figs. 14, 15, 16, and 17). Suckers and slips selected from poor plants start to grow very slowly and rarely become strong plants or produce profitable crops (fig. 14). In every case observed the best results were obtained where material was selected with the greatest care from the strongest, healthiest, and most productive parent plants. The reputed superiority of Cuban grown slips is due solely to the fact that they are larger and have usually been taken from strong, vigorous plants. Home-grown slips give similar results when selected from equally desirable plants.

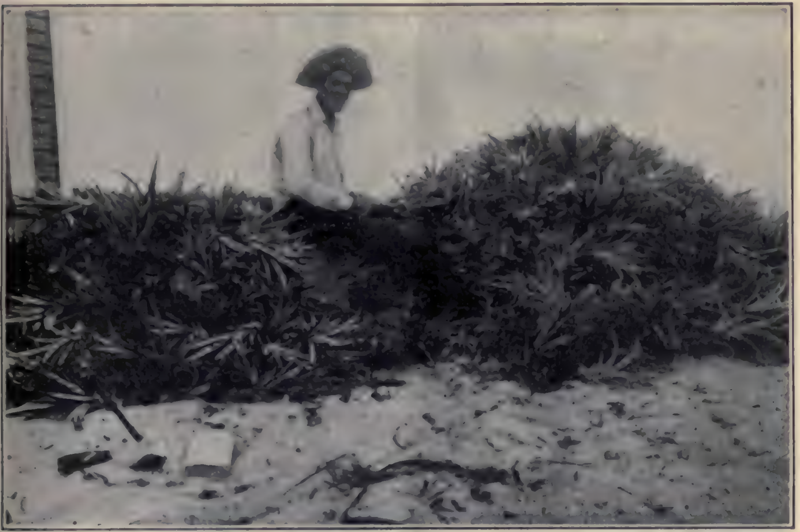

FIG. 12.—Trimming pineapple suckers and slips.

In order to insure the selection of suckers and slips from the best plants, the finest and healthiest parent plants should be marked at fruiting time, when their inherent characteristics are most apparent. They may be marked by means of stakes, by splashing a little whitewash on one or two of the most prominent leaves, or by other convenient methods. When the propagating materials are collected, the plantation owner should make sure by careful supervision that only these selected materials are taken. When parent plants have not been marked at fruiting time or when an insufficient number have been so marked, special care should be taken to see that slips are collected from the healthiest and most vigorous plants in the field.

There is no longer any doubt that the proper selection of the best parent plants, long recognized as most important with other crops, is just as essential to the best results in pineapple growing. By careful selection of suckers and slips the size and quality of pineapples can be greatly improved. Many of the failures in the past have been due in large measure to the careless selection of slips especially to the use of slips from weak or undersized plants.

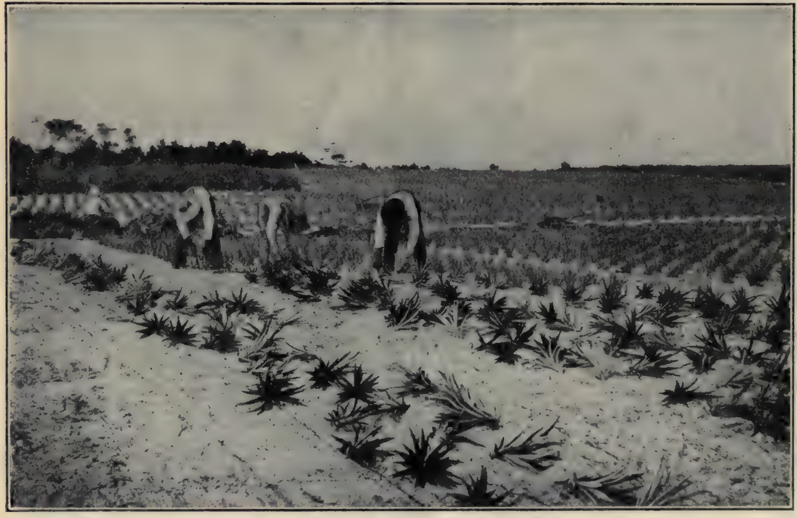

FIG. 13.—Setting pineapple plants. Strong, healthy slips are being planted.

MANAGEMENT OF PINEAPPLE PLANTATIONS.

CLEARING AND MARKING OFF THE FIELD.

When virgin land is to be planted the timber growth usually i grubbed off, although pine stumps, which quickly decay, are sometimes left in place. After grubbing, the brush and roots are burne (fig. 18); however, this should not be done on the land to be planted as fire destroys much of the valuable humus of the soil. After th land has been deeply plowed and leveled it is ready for marking off.

SPACING DISTANCE.

The fields are laid off for planting with a plow or a marker similar to that used in planting corn. In the commonly used wide-bed system, plants are usually spaced 22 inches apart in rows which are also 22 inches apart. Six rows constitute a bed, and every seventh row is skipped and left as an aisle between two beds. Two rows are omitted after every third bed for a roadway. Approximately 10,000 slips are required to plant 1 acre with this spacing.

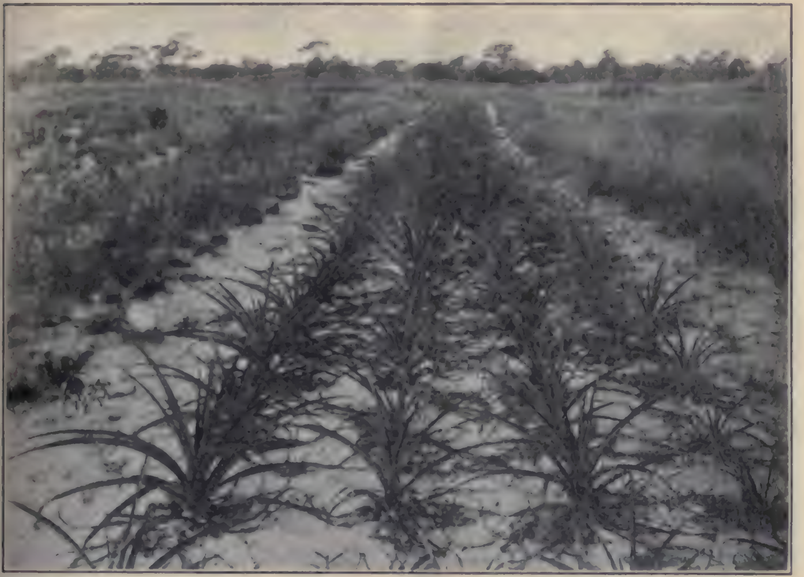

FIG. 14.—A 1917 planting of pineapple slips that were undersized in land that had not been improved, photographed in May, 1921. There are several patches of red wilt, but the plat is not seriously affected as a whole. Only 14 per cent of the plants are fruiting. Poor slips in unimproved soil mean failure.

In the Cuban planting system (fig. 19) occasionally followed, plants are set 10 inches apart in double rows, which are 12 inches apart, with 6 feet separating the pairs of rows. This system saves hand labor by permitting cultivation with horse-drawn implements during the first two years after planting; further, the fruit produced averages somewhat larger than where the wide-bed system is used. The losses from sunburned fruit are much greater, however, as the plants shade each other less than in the wide-bed system. The depletion of humus due to exposure to the sun is another disadvantage of the Cuban system.

GENERAL CULTURAL METHODS.

A few days after planting, a tablespoonful of cottonseed meal is dropped into the bud of the slip. This practice, known as "budding," results in the formation of a hard core, which prevents sand from blowing in and smothering the bud.

The general care of the pineapple field is comparatively simple, consisting mainly of three or four annual cultivations with the scuffle hoe to keep down the weeds. Care should be taken during the hoeing and other cultural operations to avoid breaking the brittle pineapple leaves, as when these are injured they lose moisture to such a extent that the plant may be seriously damaged.

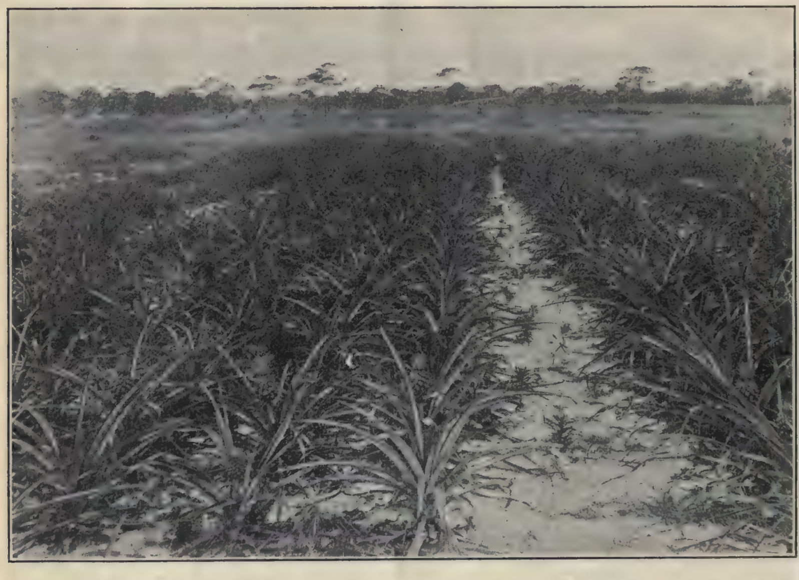

FIG. 15.—A 1918 planting of pineapple slips that were better than those used in 1917, but still below the standard, photographed in May, 1921. One year's growth of Natal grass was turned under. The plat is practically free from red wilt, and 31 per cent of the plants are fruiting.

FERTILIZATION.

Most Florida pineapple soils are very low in fertility and requir heavy applications of fertilizers as well as the addition of humu for the production of profitable crops. Many systems of fertilization are used successfully. The Florida Agricultural Experimen Station recommends for the average soils of the east-coast pineappl belt from 3,500 to 4,000 pounds to the acre annually of commercia fertilizer analyzing 5 per cent nitrogen, 4 per cent available phos phoric acid, and 10 per cent potash, applied in four applications a year for the first 18 months after the field is planted.[4]

It is further recommended that after this a similar yearly amount be given in two applications, namely, in February, and in July after harvest. Nitrate of soda may be used during the first six months after planting, but after that time organic forms of nitrogen, such as tankage, cottonseed meal, and dried blood give the best results. Finely ground steamed bone is recommended as preferable to acid phosphate as a source of phosphorus and sulphate of potash as preferable to muriate of potash.

The fertilizing methods used by successful growers vary greatly and there is very little agreement as to what constitutes the best practice. A number of successful growers apply a ton of tankage to the acre in July after the main crop is harvested and add a light dressing of tobacco stems in the fall or in early spring. Other leading growers have obtained excellent results from an application of about 1,500 pounds of standard commercial "pineapple fertilizer" in February, followed by a second similar application after harvest and a third application of 1,000 to 1,200 pounds of tobacco stems in early winter. A beginner in pineapple growing should follow the methods found most successful by experienced growers in his immediate vicinity. At the same time he should carefully experiment

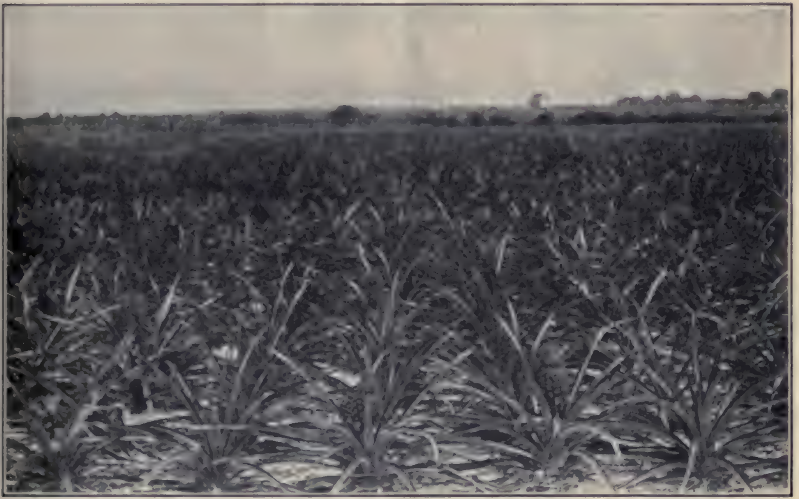

FIG. 16.—A 1919 planting of pineapple slips that were somewhat above the average in size and vigor, photographed in May, 1921. A growth of Natal grass for two years was turned under. There are no signs of red wilt, and 74 per cent of the plants are fruiting.

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[4] Miller, H. K., and Blair, A. W. Pineapple culture. III. Fertilizer experiments. Fla. Agr. Exp. Sta. Bul. 83, p. 436. 1906.

with different combinations of fertilizers, in order to determine the best method of fertilizing for his own particular conditions.

SHED CULTURE.

For growing pineapples in sections too cold for culture in open fields and also where the protection of fancy tender varieties is desired, protecting sheds are often used. All of the plants in the vicinity of Punta Gorda (see fig. 1, *C*), where the choice, tender Cayenne variety is grown, as well as most of the few plantings in the central counties (fig. 1 *D*) are provided with shed protection. In addition to furnishing to the plants marked protection from the cold, these sheds prevent excessive evaporation from the soil and the foliage of the plants, thus conserving the moisture. When grown under sheds the plants are usually more vigorous and productive and the fruit is larger, better in dessert and shipping quality, and freer from sunburn than if the plants were grown in the open (fig. 20). For these reasons sheds are sometimes used in regions comparatively free from frosts.

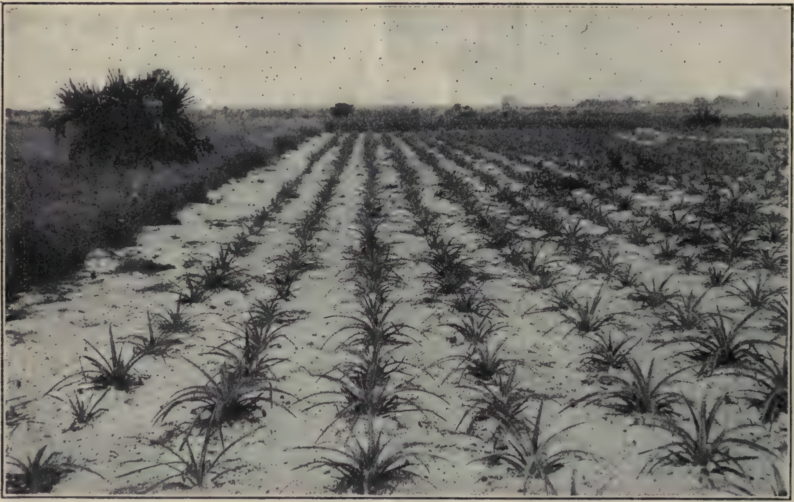

FIG. 17.—A 1920 planting of pineapple slips somewhat below standard, photographed in May, 1921. A growth of Natal grass for three years was turned under. In a few months they will equal in size the 1917 plantings of poor slips in poor soil and will probably produce a good crop in 1922. Natal grass sod is shown at the left and a 1919 planting of pineapples in the background.

The methods of constructing sheds vary with the material available. The sheds are usually made 6 to 7 feet high to allow perfect freedom in working under them. A plan of construction frequently used is to set pine posts firmly in the ground about 9 by 14 feet apart, with stringers of 1 by 8 inch material attached to the top of these posts running the 14-foot way. A narrower strip placed below the main stringers is nailed to the posts, running the 9-foot way, to give additional firmness. The roof is made of common building lath or of 1 by 3 inch pine boards 18 feet long nailed to the stringers, leaving a 3-inch space between boards. It is a generally recognized principle that regardless of other details of construction the best results are obtained when about one-half shade is provided.

In the colder localities of Florida where pineapples are grown sheds are usually provided with side walls of cloth or boards, used for additional protection during severe freezes.

The cost of construction of pineapple sheds in 1918 averaged in the neighborhood of $800 an acre, and the annual expense for upkeep was about $75. While plants grown under sheds are more vigorous than those grown in the open, they are not free from disease, and in view of the increasing difficulty in securing profitable yields under any condition few growers feel justified in making the large investment required for shed construction and upkeep. The use of sheds in the future will probably be largely confined to the production of fancy, high-priced varieties, which are most likely to repay the extra investment and care involved.

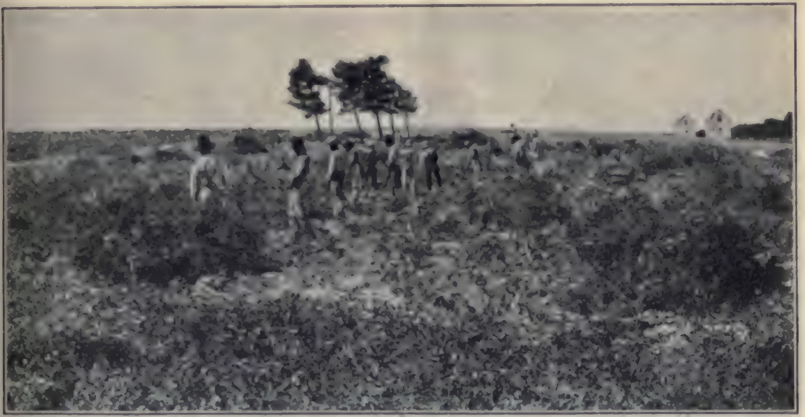

FIG. 18.—Clearing land for pineapples.

HARVESTING AND MARKETING.

Although some fruits ripen and are shipped at all seasons of the year the main harvest season for Florida pineapples extends from late May to mid-July. In harvesting, laborers protected from the sharp spines of the plants by heavy canvas gloves and leggins proceed through the fields, break the fruits from the plants, and toss them to other laborers stationed in the aisles between the beds (fig. 21), who carefully catch the fruits and deposit them in the field crates. The fruit is then hauled to the packing house by wheelbarrow, wagon, or motor truck (figs. 22, 23, 24, and 25), where it is in turn sized, graded, wrapped in tissue paper, and packed in crates holding 18 to 56 pineapples (figs. 26 and 27), depending upon the size of the fruit. The unique methods of harvesting and gathering pineapples and the great activity during the height of the shipping season furnish a most interesting and picturesque spectacle.

NECESSITY FOR MORE CAREFUL HANDLING OF THE FRUIT.

Investigations of the Bureau of Plant Industry of the United States Department of Agriculture conducted in Florida and other investigations made in the West Indies[5] have demonstrated that greater care should be used in all the operations of harvesting, packing, and shipping the fruit, in order to prevent punctures and bruises which are the chief sources of decay. It has been shown that fruit should be shipped as promptly as possible after picking, as its keeping quality is greatly impaired by delay either in the field or packing house, especially when the weather is warm; also that fruit should be packed only when it is dry, as decay is greatly favored by the presence of moisture. Neglect to handle the fruit carefully and ship it promptly often results in very heavy losses, the pine

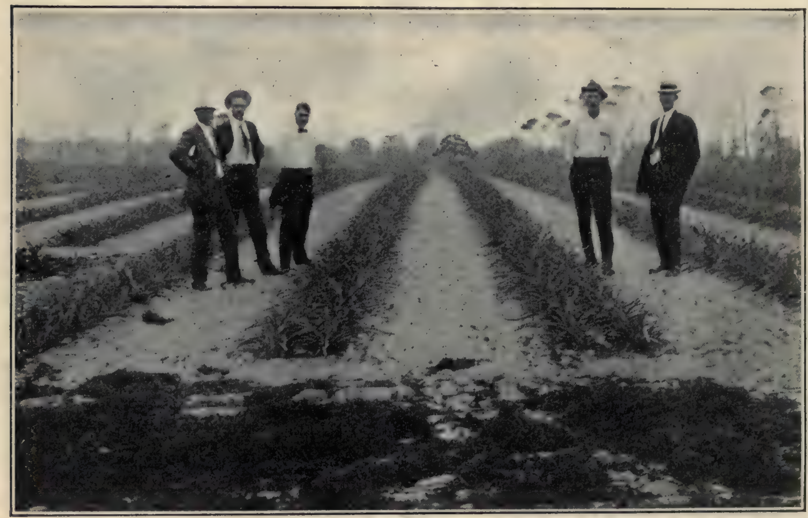

FIG. 19.—Pineapples planted by the Cuban or double-row method. This system permits cultivation by horses, but increases the loss from sunburn.

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[5] Mann, C. W. The handling of Porto Rican oranges, grapefruit, and pineapples Porto Rico Insular Exp. Sta. Bul. 7, 59 p., 24 fig. (on 13 pl.). 1914.

apples arriving at the northern markets in an almost unsalable condition on account of extreme decay.

PLANT-RIPENED PINEAPPLES.

For shipping to distant markets, pineapples are usually picked and packed while still hard and green. While this green fruit becomes yellow and edible before it reaches the consumer, it is never equal in sweetness or flavor to fruit which has been permitted to ripen on the plant. The reputation made by the canned pineapples imported from Hawaii is largely due to the fact that this fruit is picked only when fully matured.

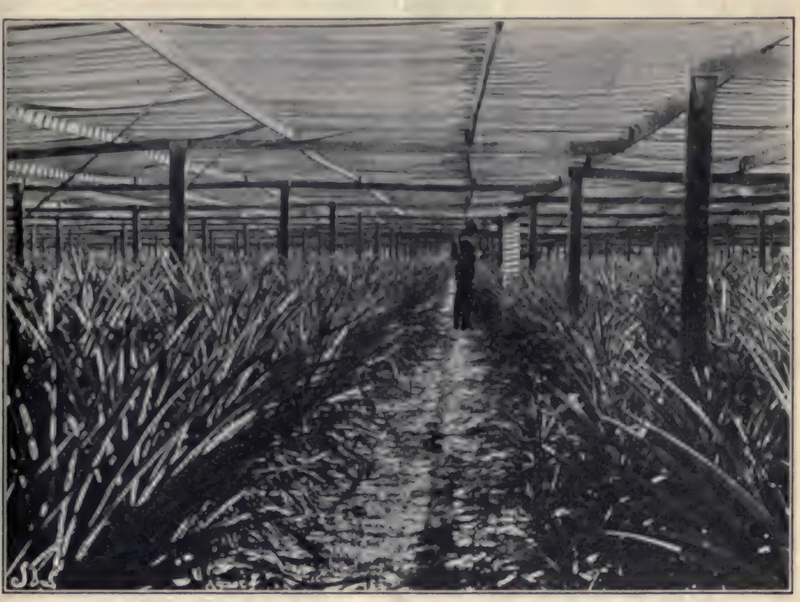

FIG. 20.—Vigorous pineapple plants growing with shed protection.

Experiments of the Bureau of Plant Industry of the United States Department of Agriculture have shown that the superior plant-ripened fruit, if picked at the proper stage of maturity, carefully handled, and promptly shipped in iced cars, may be sent to northern markets with very little decay.

The best stage of maturity for picking plant-ripened fruit was found to be the hard-ripe, or "ruddy-ripe," stage, when the pineapple has turned to a reddish yellow but before it becomes fully yellow or soft. At this stage of maturity the fruit has reached the acme of dessert quality but is still firm enough to permit shipping for long distances if properly handled.

This method of shipping plant-ripened fruit has many possibilities and is considered of special promise for growers who raise the choice varieties for the fancy-market trade.

When green fruit is shipped in the ordinary way and allowed to ripen en route to market, only fully grown pineapples with well-developed eyes having a trace of light green showing between them should be picked. Purplish green fruit and fruit with partially developed or shrunken eyes should be left on the plants until they have reached the condition described above.

Immature fruit is low in table quality and ships and keeps poorly. Overripe, soft, or defective fruit should be excluded from the general pack and canned, sold on the local market, or otherwise used. The question of proper maturity for picking as well as the factors involved in the careful handling of fruit to prevent decay demands closer attention from pineapple growers than has usually been given. Further information relative to methods of shipping and handling pineapples may be obtained by addressing the United States Department of Agriculture.

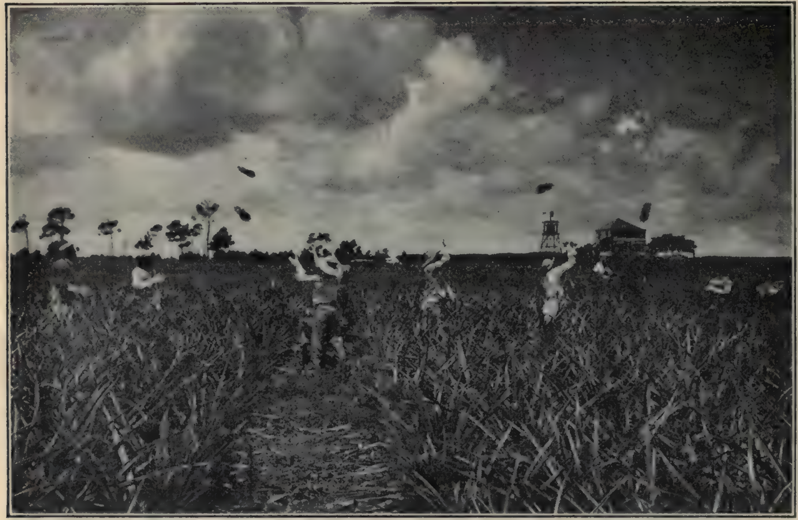

FIG. 21.—Picking pineapples. The "pines" are broken from the plant and thrown to laborers in the aisles, who catch them and deposit them in field crates.

YIELDS AND PROFITS.

When vigorous, healthy, carefully selected slips have been planted under favorable conditions, the first crop of pineapples is harvested about 20 months after planting, and annual crops are secured thereafter during the life of the plantation. Yields vary greatly, depending upon the skill of the grower, the season, and other factors. A yield of 200 crates to the acre was formerly considered a good average, although some growers secured 300 crates or more. Prices have fluctuated greatly, but in average seasons have been quite satisfactory, and frequently additional receipts are obtained from the sale of slips. Taken as a whole, the pineapple industry up to about 1917 was profitable and yielded satisfactory returns (fig. 28). At the present time (1920) prices for pineapples are higher than ever before, but, for the reasons mentioned, production and profits in most fields have reached the vanishing point.

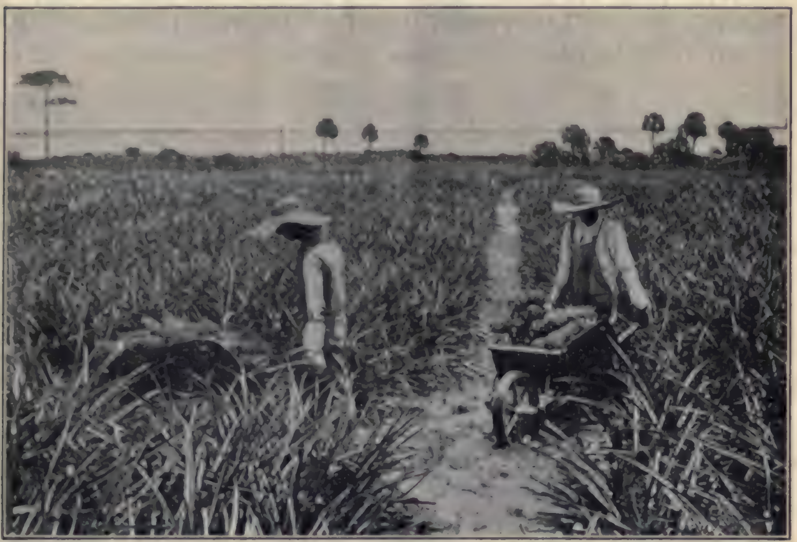

FIG. 22.—Collecting pineapple fruit for hauling to the packing house.

BEARING LIFE OF PLANTATIONS.

The period during which pineapple fields bear profitable crops varies with the site, soil, care, and other factors.

Plantings made in the earlier days of the industry on virgin soil, comparatively free from disease, occasionally bore profitably for 10 years or even longer, although in most cases production declined so rapidly after the fifth year that further maintenance was unprofitable. In more recent years the depletion of soil humus and the increasing prevalence of disease have greatly shortened the productive life of plantations. Most fields set out since 1915 were abandoned after the second or third year and many were given up before a single paying crop was secured. The condition of the industry has grown steadily worse, and the severe freeze of February, 1917, so greatly damaged the already weak and diseased plants that most of the fields have been abandoned altogether. Many attempts have been made to clear and replant these abandoned fields, but while replanting was often successfully accomplished in the earlier years of the industry, most of the attempts in recent years have been complete failures. Many reasons have been advanced to explain the decline of the industry, including inferior fertilizers, particularly unfavorable seasons of weather, high freight rates, labor costs, and other causes. The chief reasons, however, are now determined to be the depletion of soil humus, the prevalence of wilt, and the scarcity of desirable slips.

In replanting, old plants are usually grubbed out and burned. A number of growers have spaded them into the ground at considerable cost, with the idea of adding humus to the soil. However, new plantings made where the old diseased ones have been spaded in, though starting to grow vigorously, have in nearly every case died out on account of wilt after the first or second year. The practice of spading under the old plants and resetting immediately does not seem, therefore, to be advisable. Better results have been obtained by plowing rotted leaves and litter from woodlands into the soil. The most desirable measures to be taken before replanting are those described in connection with the discussion on the restoration of the pineapple industry.

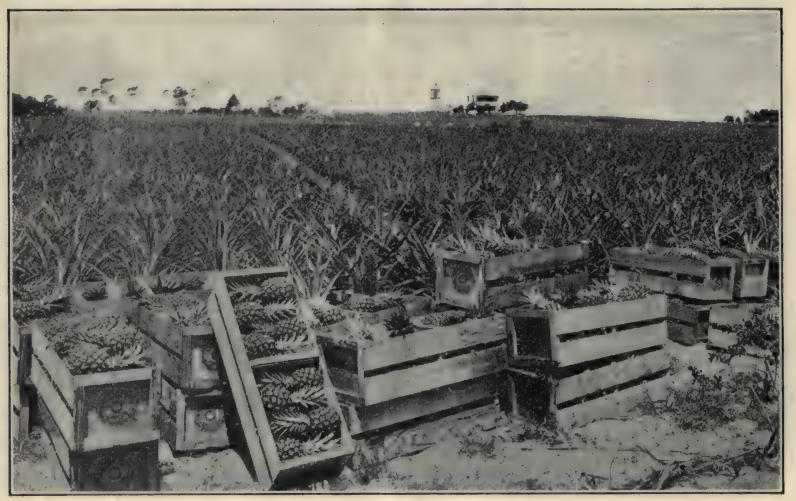

FIG. 23.—Pineapples piled in field crates ready for hauling to the packing house.

PESTS AND DISEASES.

PESTS.

Among the several pests found in Florida pineapple fields are the red spider, which attacks the basal part of the leaves, and the mealy bug, which feeds on the buds and the leaves. Both of these pests are common, but they seldom inflict severe damage. Usually their attacks can be diminished by dropping a handful of tobacco dust into the bud of the plant.

DISEASES.

The soft, dark, fermented, decayed condition of the fruit, frequently associated with heavy loss in pineapple shipments and commonly called soft-rot, is caused by the attacks of a fungus (*Thielaviopsis paradoxa*), which enters the fruit through bruises, punctures, and through the cut stem end. While decay due to this fungus is seldom great in the fields, it is sometimes so severe among pineapples in transit to market as to cause almost a total loss of the shipment. This loss is particularly liable to occur in warm, humid weather, especially when the fruit has been roughly handled, packed while wet, or delayed before shipment,[6] the decay spreading rapidly from one affected fruit to other fruits in the same package. Pineapples that have been packed when mature, carefully handled, graded, and properly shipped are seldom seriously affected.

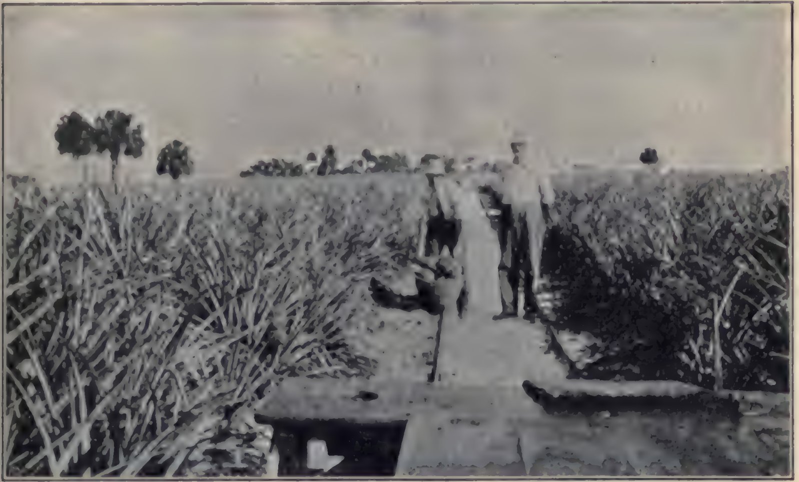

FIG. 24.—A track laid in light sandy soil to facilitate hauling by a motor truck. This view shows the topography of the east-coast pineapple region near Fort Pierce, Fla.

"Spike" or "long-leaf," a condition characterized by long, spindling or spiky leaves, most frequently occurs among pineapples grown on shell lands or other soils high in carbonate of lime, and these soils should be avoided in selecting a site for a plantation. There is some evidence that in a number of cases heavy applications of commercial fertilizers, particularly muriate of potash, inorganic forms of nitrogen (commonly referred to in terms of ammonia), and acid phosphate have been followed by the appearance of "spike."

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[6] Higgins, J. E. The pineapple in Hawaii. Hawaii Agr. Exp. Sta. Press Bul. 36, 34 p., 15 fig. 1912.

RED WILT.

The most widespread and destructive disease of pineapples in Florida is red wilt, also called wilt, or blight. It has been a chief cause of the decline of the industry in that State.

Plants affected with wilt gradually lose their normal healthy green color and assume a dull reddish hue. Usually the lower leaves are first affected, but the entire plant eventually becomes red and limp and finally droops and dies. The disease commonly appears first in a few individual plants or groups of plants scattered here and there about the field, but it gradually spreads through the entire planting (figs. 29 and 30). The affected plants sometimes survive the attacks for months, especially when the weather and other growing conditions are favorable, but in most cases they die rapidly after the first symptoms of disease appear. The roots are found to be rotted to a considerable extent, even in early stages of the disease.

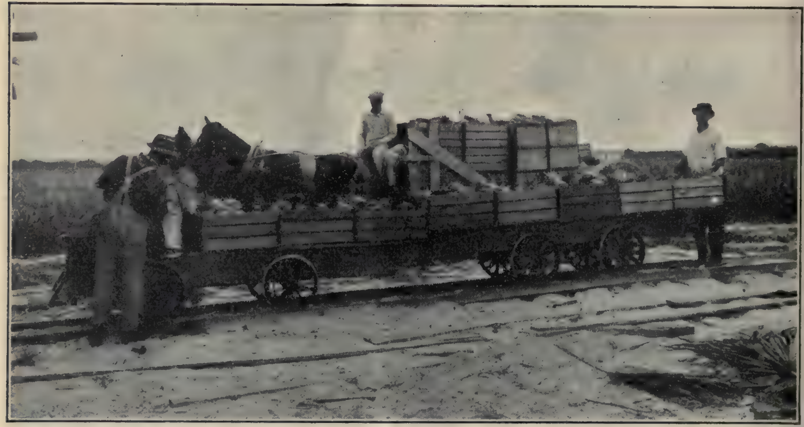

FIG. 25.—A motor truck loaded with pineapples on the way to the packing house.

THE RELATION OF RED WILT TO NEMATODES.

Although many theories have been advanced in explanation of the causes of red wilt, recent investigations[7] indicate that it is a diseased condition of the plant due, at least in large measure, to the attacks of nematodes (*Heterodera radicicola*), minute parasitic ground worms which infest most of the light soils of the South and which are present in countless numbers in most of the Florida pineapple fields. These nematodes attack the pineapple plant by penetrating and destroying its fine feeding roots, thus gradually depriving the plant of its means of taking up food and water until, when all the feeding roots are killed, the plant dies. The root galls caused by the initiation of the nematodes are less conspicuous on pineapples than on other hosts of this pest, and the infested roots have a tendency to decay rapidly. A plant infested with nematodes has much the same appearance as if it were suffering from drought or lack of fertilizer, and this fact has resulted in much of the confusion regarding the real cause of the trouble (fig. 29). The wilting of pineapples in ways more or less similar to those characteristic of the Florida red wilt has been described from various parts of the world. It is possible that some of the diseases so described may have the same cause as the Florida red wilt.

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[7] Sherbakoff, C. D. Pineapple wilt. *In* Fla. Agr. Exp. Sta. Rpt., p. 93R–98R, fig. 15–16. 1917.

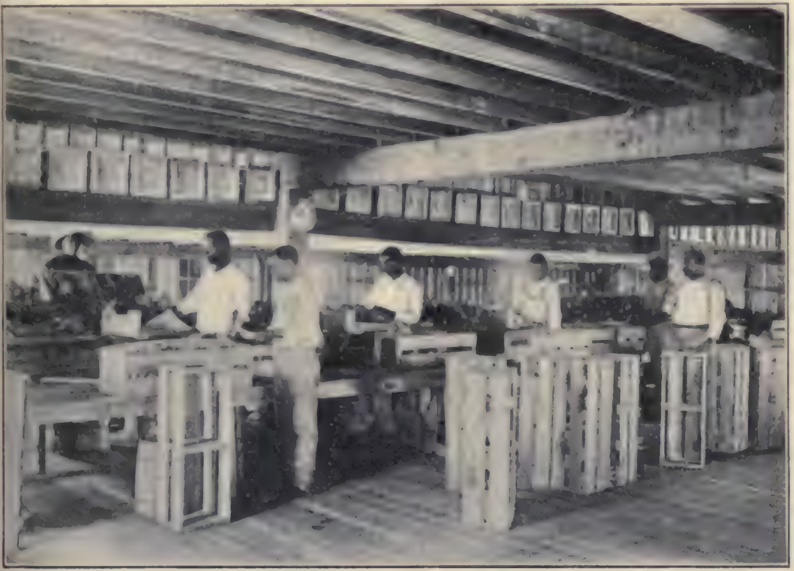

FIG. 26.—A packing-house scene.

Nematodes are readily carried from infested land to new soils on the feet of men or animals, on tillage implements, and in many other ways. Red wilt is usually first seen among pineapple plants adjacent to roadways, where they would be most liable to infestation in this way. Moreover, when pineapples are planted on cleared land adjacent to diseased fields the wilt first appears on those plants which are nearest to the old infested area. Slips from fields infested with wilt may possibly carry nematodes to new fields by coming in contact with infested soils. Many native weeds are hosts for the nematode, and virgin land is not always entirely free from the pest. The infestation in abandoned fields is maintained on many of the weeds springing up naturally. The spread of wilt is often very rapid, pineapple plants on new fields usually showing symptoms within a year or two after the land has been planted. The spread often follows natural drainage slopes by the washing of infested soil.

CONTROL OF RED WILT.

Many methods of combating red wilt have been tried, but these have been generally unsuccessful, owing to the lack of understanding of the real nature of the disease. Slips have been brought from Cuba and other distant points in the expectation that they would prove free from disease. There is no evidence to show that the imported slips are in any way more desirable than equally healthy, vigorous, home-grown slips. Besides, there is always the chance of introducing some unsuspected pest on plant material from outside sources. While the planting of good slips is of the utmost importance, not even the best of them can be expected to survive on soil depleted of fertility or infected with disease.

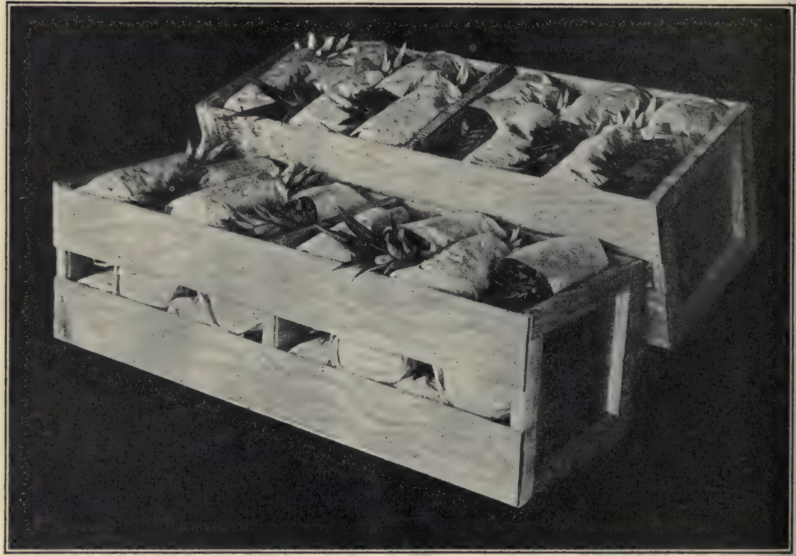

FIG. 27.—Packed crates of pineapples ready for shipment.

Another control measure which has been tried is that of spading calcium cyanamid into the soil at the rate of 1 ton or more to the acre.[8] The method has given some measure of success, but it is too expensive for general application.

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[8] Watson, J. R. Control of root-knot by calcium cyanamid and other means. Fla. Agr. Exp. Sta. Bul. 136, pp. 145–160, fig. 67. 1917.

All varieties of pineapples grown in Florida are attacked by the nematodes. The Spanish is less susceptible, however, than the Cayenne. Investigations made by the Bureau of Plant Industry of the United States Department of Agriculture with the object of selecting resistant strains or varieties may eventually prove successful, but at the present time the only promising plan of controlling wilt is that of first freeing the soil of nematodes, as discussed under the heading "Restoration of the pineapple industry."

DEPLETION OF SOIL HUMUS.

Red wilt due to the attack of nematodes is closely associated with an equally important cause of the decline of the pineapple industry, namely, the depletion of the humus or decaying vegetable matter in the soil. The destruction of humus through constant cultivation and the exposure of the light sandy soil to the tropical sun proceeds at a very rapid rate. Even in their virgin state Florida pineapple soils are poor in humus, and after a few years of intensive cultivation this scanty supply is almost exhausted, and the soil is left in an unproductive state, low in fertility, and lacking in soil organisms essential to healthy plant life. In such impoverished soils pineapples can not be expected to grow satisfactorily, even if no disease is present to further impair the vitality of the plants.

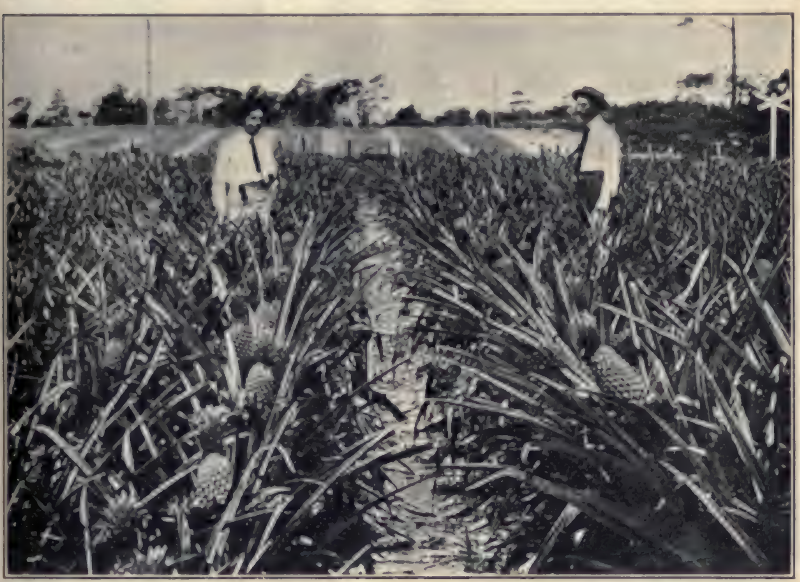

FIG. 28.—A productive pineapple field.

Pineapple culture on the keys and in other Florida sections was abandoned when the vegetable matter of the soils of the region became exhausted, and fields which have been long under cultivation or exposed to the sun for any length of time can seldom be successfully replanted. It is clear, therefore, that in restoring abandoned pineapple fields the replenishment of the diminished humus supply must be given full consideration.

RESTORATION OF THE PINEAPPLE INDUSTRY.

The chief problem which must be solved before pineapples can be replanted in Florida is the reduction of the number of nematodes and the restoration of the depleted soil humus. Fortunately, the remedial measures most promising in controlling nematodes are also most successful for replenishing soil fertility and humus.

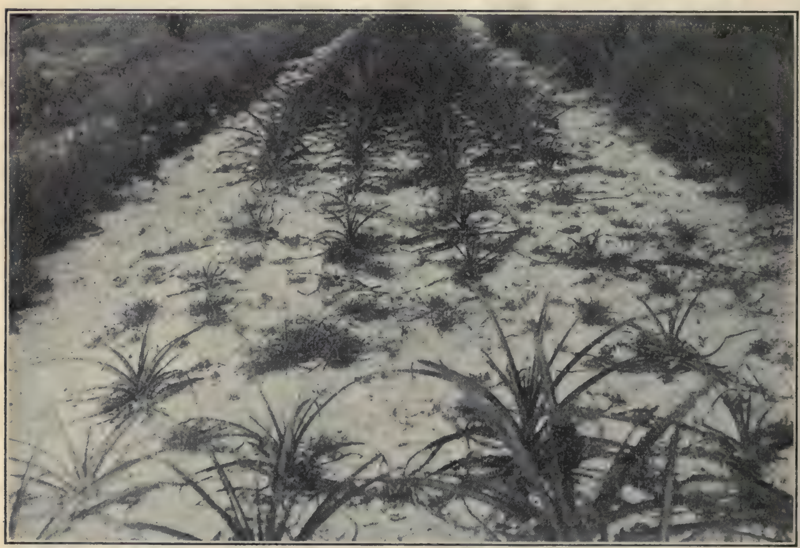

FIG. 29.—A typical spot in a field infected with red wilt. Photographed May, 1921, in the 1917 planting of pineapples shown in figure 14.

A number of the crops, particularly Natal grass, velvet beans, and the Iron or other nematode-resistant varieties of cowpeas, which can be grown even in the light soils of the old pineapple fields, are nearly or quite immune from attacks by nematodes. By growing these crops for a period of several years the pests can be starved out, and at the same time the fertility of the soil can be built up to a degree favorable to the growth of pineapples. Preliminary results from experimental plantings made by investigators of the Bureau of Plant Industry[9] have shown that of these crops Natal grass (*Trich-*

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[9] Fulton, H. R., and Winston, J. R. Prevention of root-knot in pineapples. *In* Fla. Grower, v. 20, no. 17, p. 7, illus. 1919.

olaena rosea Nees)[10] makes by far the quickest and heaviest growth, and of all crops tried it is the most satisfactory and cheapest to plant. After land had been sown and allowed to remain in Natal grass for two years or more it was found that the nematodes had practically disappeared and that, moreover, the soil had become darker in color and rich in humus and fertility. Healthy, vigorous slips recently planted on this restored land have given every promise of high future production. (Figs. 16 and 17.) Plants growing vigorously under such favorable soil conditions suffer less from cold injury than less vigorous plants. They are able readily to replace roots that may be destroyed by nematodes and so can withstand moderate attacks of this pest.

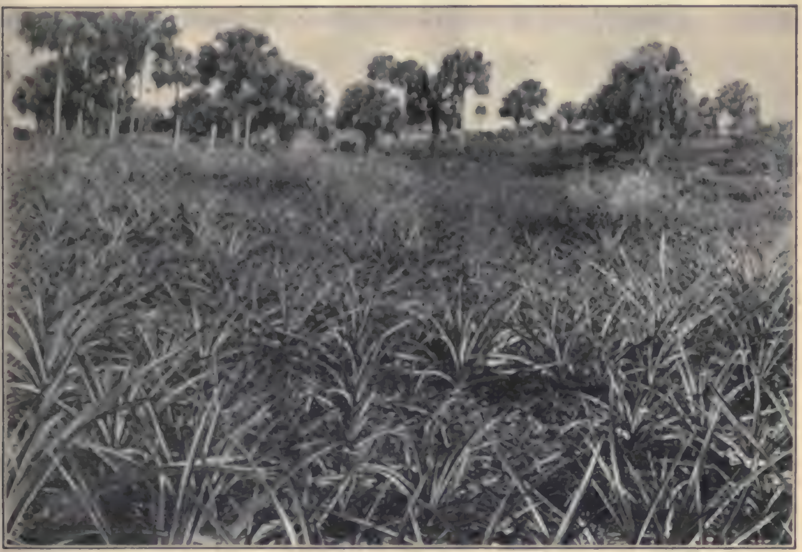

FIG. 30.—Pineapple plants on hammock soil rapidly succumbing to wilt.

A PRACTICAL METHOD OF RESTORING ABANDONED PLANTATIONS.

In conformity with the results thus far obtained in these experimental plantings, it is suggested that owners of land formerly planted to pineapples who desire to put it in good shape for replanting proceed in the following manner: The old plants that remain should be first gathered and then removed or left to rot on the land. Natal grass seed should be sown broadcast at the rate of 8 or 10 pounds per acre. This can be done at any time of the year when the soil moisture is sufficient for germination, but preferably in the fall. Under ordinary conditions this grass will quickly make a good start and should be left undisturbed and allowed to reseed itself at will (fig. 31). It will probably be effective to allow the land to remain in Natal grass for two years, but if the soil is in a very impoverished condition or badly infested with nematodes, three years or longer may be necessary.

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[10] Fulton, H. R., and Winston, J. H. [J. R.]. Natal grass and the control of pineapple root-knot. *In* Fla. Grower, v. 22, no. 16, p. 22. 1920.

Tracy, S. M. Natal grass, a southern perennial hay crop. U. S. Dept. Agr. Farmers' Bul. 726, 16 p., 4 fig. 1916.

Before the Natal grass is turned under, tests should be made to determine whether or not the nematodes have been starved out. A few pepper plants may be set in spots here and there through the field. If these grow vigorously, with roots free from the nematode galls, it may be assumed that the nematodes are practically eliminated, because peppers are very susceptible to attack by this pest and would be affected where nematodes are abundant. After tests made in this way indicate that the nematodes have been sufficiently reduced or eliminated, the Natal grass can be plowed under and pineapples replanted.

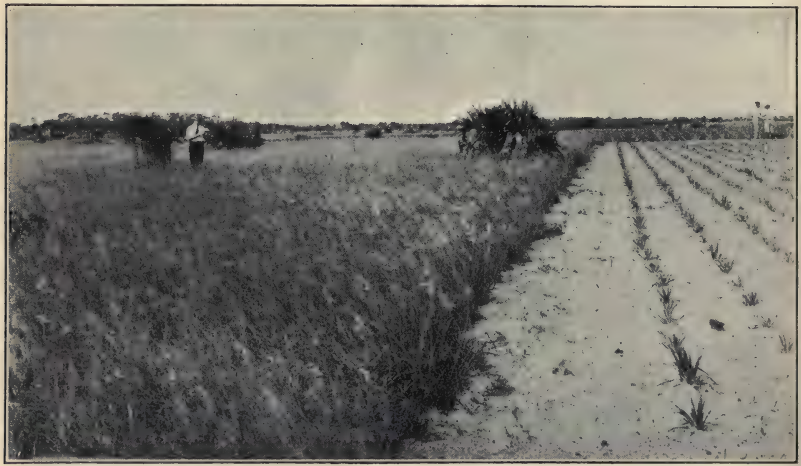

FIG. 31.—A field in Natal grass at the left. At the right is a field in which Natal grass has recently been plowed under and pineapples set out.

In replanting, the most vigorous and healthy slips should be selected. The fields should then be given good care and every effort made to increase the vigor and consequently the disease resistance of the plants and to reduce the chances of nematode infestation from near-by infected fields. The soil, however, is likely to become reinfested sooner or later, often by the time three or four crops have been harvested. When the replanted fields begin to show decreased yields as a result of reinfestation, the land should be resown with Natal grass seed and that grass grown until the humus is restored and the nematodes starved out. In following this plan of restoration it will be necessary for the pineapple grower to have one-third to one-half of his acreage in Natal grass. The added fertility secured in plowing under the Natal grass should fully cover the expense involved in carrying out the plan of rotation.

Many other methods of restoring pineapple fields have been attempted, but without success. It seems certain that no plan which neglects either nematode control or humus restoration can be successful. On the other hand, a number of growers who have put into practice the plan suggested above are now securing promising results and are producing crops on a profitable basis. The building up of abandoned pineapple soil with Natal grass in the manner suggested promises to be a slow but sure method of reviving the pineapple industry not only in Florida, but in other sections where similar conditions exist.

CONCLUSIONS.

A small portion of the abandoned pineapple land, particularly that of the hammock type, is richer than the average in fertility and is well suited for the culture of vegetables and fruits, such as limes, grapefruit, and avocados. Many growers who formerly raised pineapples exclusively are planting these richer soils to some of these crops. Diversification of this sort is safer and in the end probably more profitable than specialization with a single crop, and it should be encouraged. However, as the acreage of land suitable for these other crops is limited, the future prosperity of the farmers of the pineapple section depends largely upon the restoration of the pineapple industry.

Persons contemplating going into pineapple growing should thoroughly investigate conditions at first hand before making any investment. This precaution should be taken not only by prospective pineapple growers, but also by anyone planning to grow fruit crops in Florida or any other part of the country. The rewards of fruit growing are often excellent, but success requires careful preliminary investigation, considerable skill, and hard work, particularly where the capital is limited. Pineapple growing is no exception to the rule. The new grower in Florida should consult with the agricultural investigators of the State and Federal Governments, and especially with successful and established growers. These men are familiar with the ups and downs of pineapple growing, and it is due to their determined efforts for the restoration of the industry that the future of pineapple growing now appears encouraging provided proper restoration methods are adopted.

HOW TO DO IT.

Do you want practical suggestions on how to build a silo, a hog house, a poultry house, a potato-storage house, or how to make a fireless cooker, or other farm convenience? Are you seeking ideas on how to prepare vegetables for the table, how to care for food in the home, how to bake bread and cake and other appetizing foods in an efficient and economical manner? Is there some practical question about your corn or wheat or cotton or other crops, or about your poultry or live stock, to which you are seeking an answer? The answers to thousands of such questions and practical suggestions for doing thousands of things about the farm and home are contained in over 500 Farmers' Bulletins, which can be obtained upon application to the Division of Publications, United States Department of Agriculture, Washington, D. C.

FARMERS' BULLETIN - 1238
UNITED STATES DEPARTMENT OF AGRICULTURE

LAWS
RELATING TO
FUR-BEARING ANIMALS, 1921

A Summary of Laws in the United States, Canada, and Newfoundland, Relating to Trapping, Open Seasons, Propagation, and Bounties

AMERICAN TRAPPERS receive yearly in the aggregate many millions of dollars for their fur harvest, which, up to the moment they set out to gather it, does not cost them a single effort. Recently the supply of peltries has been decreasing at an alarming rate. Raw-fur buyers representing all parts of the country place the decrease at from 25 to 50 per cent during the last 10 years. There are no longer any virgin trapping grounds. Even in Alaska the two most important fur-bearing animals, the beaver and the marten, had become so nearly exterminated that up to 1921 they were protected by a long close period.

Laws protecting fur-bearing animals are designed to keep a steady flow of peltries coming to market year after year, thereby bringing trappers a reliable income and giving regular employment to thousands of people engaged in dressing skins, manufacturing garments, and distributing them through the various avenues of trade.

A general protest comes from raw-fur buyers against traffic in unprime skins. The losses caused by killing fur animals when their pelts are not prime are enormous. An educational campaign is greatly needed to prevent this waste and to perpetuate our fur-producing resources.

It is hoped that the information contained in this bulletin, the seventh annual publication on the subject, will be instrumental in promoting judicious and harmonious action in this important matter.

Contribution from the Bureau of Biological Survey
E. W. NELSON, Chief
Washington, D. C. Issued September, 1921

LAWS RELATING TO FUR-BEARING ANIMALS, 1921.[1]

A SUMMARY OF LAWS IN THE UNITED STATES, CANADA, AND NEWFOUNDLAND, RELATING TO TRAPPING, OPEN SEASONS, PROPAGATION, AND BOUNTIES.

GEORGE A. LAWYER, *Chief United States Game Warden;* and FRANK L. EARNSHAW, *Assistant, Interstate Commerce in Game.*

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LEGISLATION OF 1921.

Half of the 42 State legislatures in session in 1921 enacted legislation relating to fur-bearing animals, the general trend of which was to safeguard and conserve these animals and to insure prime condition of peltries. The season on beavers was closed for a term of years in Indiana, Michigan, Nevada, and North Dakota, and on otter in Indiana and Nevada. Muskrats were protected until 1924 in North Dakota, which is the first time a State has been closed to the trapping of these animals. Open seasons for taking fur-bearing animals were shortened in Idaho, Indiana, Kansas, Maine, Massachusetts, Pennsylvania, Rhode Island, and Vermont; houses, dens, or burrows of fur animals were protected in Kansas, Maine, and Michigan, and further restrictions were placed on the methods of capture in Indiana, Kansas, and Nebraska. Open seasons were slightly lengthened in Michigan, Ohio, South Carolina, and locally in New Hampshire. Nebraska and Nevada now require that the skins of beavers taken under permit to prevent damage to property be turned over to the chief game warden and the county commissioners, respectively, for disposition, half of the proceeds to be paid to the permittee for trapping the animals.

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[1] Laws relating to game animals, including deer and other big game, rabbits, and squirrels will be found in Farmers' Bulletin 1235, "Game Laws for 1921."

Licenses to trap fur animals were required of residents and nonresidents in Nebraska, and fees were increased in Montana, Oregon, and Wyoming. Kansas prohibited nonresidents and aliens from trapping fur animals and prescribed a $1 license for residents; West Virginia now requires no trapping license, except for skunks.

Michigan repealed her State bounty laws and created a fund by authorizing the setting aside of part of the deer-hunting license fees for hiring trappers and hunters to destroy predatory animals. Montana provided that 25 cents of every hunting or trapping license fee be set aside as a fund to be used in cooperation with the Bureau of Biological Survey, U. S. Department of Agriculture, for the destruction of predatory animals, and the commission was further authorized to make appropriation from the funds at its disposal for the eradication of predatory animals which destroy game. The bounty on wildcat was increased in New Hampshire from $5 to $10, and in Vermont on lynx or bobcat from $5 to $8, and bounties on all predatory species were increased in South Dakota. In Pennsylvania the bounty on mink was repealed and open and close seasons prescribed for the species, and the bounty on weasel was decreased from $2 to $1.50.

Kansas and Nebraska prescribed regulations governing the raising of fur animals in captivity, and Wyoming provided that beavers may be taken under a $5 permit for propagating purposes, but prohibited the killing or sale of animals so taken for a period of 3 years.

The Secretary of Agriculture promulgated regulations under the act of February 2, 1903, effective June 1, 1921, requiring that all foxes imported into the United States for breeding purposes, except those for zoological gardens and similar institutions, shall be subject to inspection and quarantine to determine whether they have certain diseases contagious to foxes, and limiting the ports of entry.

On August 30, 1921, effective September 1, 1921, regulations relating to land fur-bearing animals in Alaska were amended by providing an open season on beaver and marten, there previously having been a closed season on beaver since 1910 and on marten since 1919, and making certain minor changes in the open seasons on other land furbearers.

SUMMARY OF LAWS RELATING TO SEASONS, PROHIBITED METHODS, LICENSES, POSSESSION, SALE, SHIPMENT, EXPORT, MISCELLANEOUS PROVISIONS, PROPAGATION, AND BOUNTIES.

In many States legislation for the protection of fur animals has not progressed to the stage of stringent regulation, and this condition, together with the peculiar commercial nature of the fur industry, makes it often exceedingly difficult to determine what restrictions, if any, apply to the transportation and marketing of furs.

In stating the open seasons, the plan of the New York law has been followed, as in the bulletin on the game laws for 1921,[2] to include *the first and the last days thereof.* Statements regarding trapping on lands of another do not take into consideration the general trespass laws of the State. The bounty laws included relate to all animals and birds on which bounty is paid.

FEDERAL LAWS.

Two Federal laws have a bearing on the fur industry of the United States—the Lacey Act, governing interstate commerce in wild animals, and the tariff act of October 3, 1913.

That part of the Lacey Act codified as section 242 of the Criminal Code (35 Stat., 1137) makes it unlawful to ship or transport "from any State, Territory, or District of the United States to any other State, Territory, or District thereof" the bodies or parts of bodies of any wild animal or bird killed or shipped in violation of the law of the State, Territory, or District in which the same were killed or from which they were shipped.

The tariff act of 1913 places a duty of 10 per cent ad valorem on live animals shipped into the United States. Paragraph 397 of this act places on the free list animals imported for breeding purposes by a citizen of the United States: "*Provided*, That no such animal shall be admitted free unless pure bred of a recognized breed and duly registered in a book of record recognized by the Secretary of Agriculture for that breed." This act has made it impossible thus far to admit free of duty any foxes or other Canadian fur animals for propagation. Raw furs not advanced in manufacture are admitted free of duty.

The Secretary of Agriculture promulgated regulations under the act of February 2, 1903, effective June 1, 1921, requiring that all foxes imported into the United States for breeding purposes, except those for zoological gardens and similar institutions, shall be subject to inspection and quarantine to determine whether they have ascarids, hookworm, lungworm, coccidiosis, mange, distemper, or any other disease contagious to foxes; limiting the ports of entry to Boston, Mass., New York and Rouses Point, N. Y., Port Huron, Mich., Calais, Me., Pembina, N. Dak., and Seattle, Wash.; and providing that the owner shall pay for the feed and care of the animals while in quarantine in quarters furnished by him and approved by the department.

LAWS OF STATES.

ALABAMA.

Open seasons:[3] *Dates inclusive.*

Beaver, otter, bear, raccoon, opossum,[4] mink, muskrat........Nov. 1–Mar. 1.

Prohibited methods: No restrictions.

Licenses: Fee, $10; issued by probate judges. Landowners or landlords, tenants, and members of families may trap on own land during open season without license. Written permission required to trap on land of another.

Possession and sale: Possession of opossum and the young of protected fur animals prohibited during close season. No other restrictions.

Shipment and export: No restrictions.

Propagation: No legislation.

Bounties: None paid.

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[2] Farmers Bulletin 1235, "Game Laws for 1921."

[3] *Alabama:* Owner may protect premises in any manner at any time from depredations of fur animals.

[4] Opossums may be hunted with dog or gun: Oct. 15–Mar. 1.

ALASKA.[5]

Open seasons:[6]

District 1.[7]	*Dates inclusive.*
Beaver	Dec. 1–Mar. 31.
Marten (American sable)	Nov. 16–Mar. 31.
Muskrat	Dec. 16–Apr. 30.
Land otter, mink, weasel (ermine)	Dec. 16–Mar. 31.
Fox, lynx	Dec. 1–Feb. 28.
Districts[2] *and 3*[9]*:*	
Beaver, marten (American sable), land otter, mink, weasel (ermine)	Nov. 16–Mar. 31.
Muskrat	Dec. 1–May 31.
Lynx, fox	Dec. 1–Mar. 15.
Throughout Territory.	
Sea otter	No open season.[10]
Bear (black, glacier, and cinnamon), wolf, wolverine, squirrel, marmot, varying hare (rabbit), and arctic hare	Unprotected.

Prohibited methods: Unlawful to take or kill fur animals with poison or by use of trap or device known as the "klips," steel bear trap, or any other trap with jaws having a spread exceeding 8 inches, by shooting, or with aid of artificial light or dog. The use of dogs for pursuing and killing protected fur animals and the use of poison for killing any land fur animal prohibited.

Licenses: None required for trapping, but trappers must keep record of all pelts taken and make annual report to commissioner on or before August 1, showing to whom and when sold or disposed of, and must pay tax on all pelts not sold to licensed fur trader in Territory. Stationary fur buyer, $25; traveling fur buyer, $150; issued by commissioner; fur buyer must also pay license tax on each pelt. License taxes on pelts: Sea otter, $100; moose trophy, $10; caribou, sheep, and goat trophies, $5; silver and black fox, $3.50; polar bear and deer trophy, $2.50; fisher, $2; blue fox, $1.50; brown and grizzly bear, cross and white fox, $1; black bear, beaver, marten, land otter, red fox, lynx, 50 cents; mink, wild cat, 25 cents; muskrat, weasel, 5 cents; pelt not specifically mentioned, 10 cents.

Possession and sale: No restrictions on prime skins legally taken.

Shipment and export: No restrictions on prime skins legally taken. Shipments of furs consigned to points outside of Alaska should be reported to the Bureau of Biological Survey, Department of Agriculture, Washington, D. C.[11]

Propagation: No restrictions except on Aleutian Islands Reservation, where permits to propagate fur animals and trap them for breeding purposes must be obtained from the Department of Agriculture. Fur farmer must obtain license, fee $25, and pay license tax on each pelt sold. Issued by commissioner.

Bounties: Wolf, $15; eagle, 50 cents.

ARIZONA.

Open seasons:

Beaver	No open season.[12]
All other fur and predatory animals	Unprotected.[13]

Prohibited methods: No restrictions.

Licenses: Fee, $2.50; issued by warden, designated deputies, and clerks of boards of supervisors. License not required for trapping on own land, nor by persons under 18 years of age. Unlawful to disturb or remove traps of licensed trappers on public domain or on lands where they have permission to trap.

Possession and sale: No restrictions.

Shipment and export: No restrictions.

Miscellaneous: Unlawful to use fish or the flesh of any game bird or animal for trap bait.

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[5] *Alaska:* Regulations relating to land fur animals may be obtained upon application to the Secretary of Agriculture, Washington, D. C. For special information regarding sea otters and fur-seal fisheries and the Afognak Reservation, which are subject to special legislative and administrative control, application should be made to the Commissioner of Fisheries, Washington, D. C.

[6] Unlawful to kill any land fur animal when its fur is unprime.

[7] *District 1* includes the Aleutian Islands, Alaska Peninsula and neighboring islands, and Southeastern Alaska, mainland and islands, from Yakutat Bay to Dixon Entrance.

[8] *District 2* includes the mainland and islands from Yakutat Bay, Gulf of Alaska, Iliamna Lake, and Bristol Bay, northward to the headwaters of the streams flowing into the Arctic Ocean north of the sixty-eighth parallel of north latitude.

[9] *District 3* includes the region drained by the streams entering the Arctic Ocean north of the sixty-eighth parallel of north latitude.

[10] Season on sea otter expires Nov. 15, 1925.

[11] Blanks for reporting shipments by mail may be obtained from postmasters and those for reporting other shipments will be supplied upon application to the Biological Survey, Washington, D. C., or to local fur wardens in Alaska.

[12] *Arizona:* Expires Dec. 31, 1922.

[13] Mountain lion, wolf, fox, coyote, lynx, wildcat, skunk, or other obnoxious animals may be taken on State game preserves only under regulations of the State game warden. Owner may protect his premises from the depredations of predatory and fur animals at any time.

Propagation: Under permit from State game warden, fur-bearing and predatory animals may be kept for propagation, exhibition, or sale.

Bounties: Payment of bounties is optional with county board of supervisors.

ARKANSAS.

Open seasons:[14]	*Dates inclusive.*
Bear	Nov. 10–Jan. 15.
Beaver, otter	Jan. 2–Mar. 1.[15]
All other fur animals	Oct. 1–Mar. 1.

Prohibited methods: Unlawful to trap bears, or to hunt them at night with torch or searchlights.

Bag limits: One bear a season.

Licenses: Trapping license, $20 (only required for use of 12 or more traps). Hunting license required to kill bears: Resident, $1.10; nonresident, $15; dog, used in hunting bears, $1.50.

Possession and sale: Sale of raw skins is prohibited except between October 1 and March 15. Sale or exchange of bears prohibited.

Shipment and export: No restrictions except on bears, the export of which is prohibited except by nonresident licensee under affidavit that the bear was legally taken and is not for sale.

Propagation: The Fish and Game Commission is authorized to issue permits to breeders of game and fur animals under such regulations as it may prescribe.

Bounties: County courts may offer bounty on wolf, wildcat, or panther, and fix the amount of such bounty.

CALIFORNIA.

Open seasons:[16]	*Dates inclusive.*
Black or brown bear, ring-tail cat, coon, pine marten, fisher, wolverine, mink, skunk, river otter, fox	Oct. 15–Feb. 28.
Seal and sea lion (in Game District 19, no open season)	Unprotected.
Beaver, otter	No open season.

Prohibited methods: Unlawful to use poisons or gun larger than No. 10 gauge in taking fur animals, or to dig, or smoke out skunks from dens.

Licenses:[16] Citizen, $1; alien, $2; issued by Fish and Game Commission. License issued free to veterans of Civil War. Duplicate license issued only on affidavit of applicant that original has been lost or destroyed. License not required of person under 18 years of age. Licensed trappers required to report catch before July 1. Licensee must exhibit license and furs to wardens or peace officers upon demand. Unlawful to disturb or remove traps of licensed trapper who is trapping on the public domain or on lands where he has permission to trap.

Possession and sale: No restrictions.

Shipment and export: No restrictions.

Propagation: Fur animals may be raised in captivity under regulations of the commissioners.

Bounties: Mountain lion, female, $30; male, $20; paid by Fish and Game Commission. Boards of supervisors of counties may fix the rate and pay bounty on coyote, wildcat, fox, lynx, bear, or mountain lion. Many counties now pay a bounty on some of these animals, especially on coyotes.[17]

COLORADO.

Open seasons:[18]	
Beaver	No open season.[18]
All other fur animals	Unprotected.[19]

Prohibited methods: No restrictions.

Licenses: Hunting license required to trap: Resident: General, $5; limited (1921), $1, (1922), $2 (for coyote, mountain lion, wolf, bobcat, lynx), nonresident, $25; issued by commissioner, county clerks, and other agents. Unnaturalized resident not permitted to hunt, capture, or kill any wild bird or animal.

Possession and sale: No restrictions.

Shipment and export: No restrictions.

Miscellaneous: Use of game or fish for trap bait prohibited.

Propagation: No restrictions, except as to beaver and game animals.

Bounties: None paid by State since 1895. On petition of 50 freeholders, county commissioners may levy a tax to pay bounties on coyote, wolf, and mountain lion.

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[14] *Arkansas:* Fur animals found destroying crops or poultry may be killed at any time.

[15] After Jan. 1, 1922, when a close term expires, the full open season will be Oct. 1–Mar. 1.

[16] *California:* Written permission from board of fish and game commissioners required to trap or hunt predatory animals on State game refuges.

[17] For information in regard to bounties in any county, application should be made to the county clerk.

[18] *Colorado:* The owner of property being damaged by beaver may be permitted to kill them under such regulations as may be provided concerning disposition of the skins, by the State game and fish commissioner.

[19] A permit from the State game and fish commissioner is necessary to take mountain lion, wolf, coyote, fox, lynx, wildcat, mink, marten, or wolverine on Colorado State Game Refuge.

CONNECTICUT.

Open seasons: [20]	*Dates inclusive.*
Otter, mink, muskrat	Nov. 1–Mar. 14.
Raccoon	Oct. 15–Jan. 31.
Skunk	Nov. 1–Jan. 31.
Other fur animals	Unprotected.

Prohibited methods: Unlawful to trap with scented baits or to take animals with a snare or similar device. Traps must be visited at least once in 48 hours, and, on lands of another, must not be set in path, wood road, or specially prepared furrow. Owner or person using traps must have his name legibly stamped thereon.

Licenses: Hunting license required to trap: Resident, $1.25; nonresident, $10.25; alien, $15.25; issued by city or borough clerk. Person under 16 years of age denied a hunting license, but may obtain one for taking fur animals only. License not required of resident hunting or trapping on own land during open season. Permission of owner required to trap on lands of another.

Possession and sale: No restrictions on skins legally taken.

Shipment and export: No restrictions on skins legally taken.

Propagation: No restrictions on possession or sale of fur animals kept in captivity.

Bounties: Towns permitted to pay bounty on wildcat or fox (not over $5); on weasel, woodchuck, wild Belgian hare, or wild German rabbit (not over $1).

DELAWARE.

Open seasons: [21]	*Dates inclusive.*
Skunk, mink, otter	Dec. 1–Mar. 10.
Fox	Oct. 1–Apr. 30.
Raccoon, opossum	Oct. 15–Jan. 15.
Muskrat	Dec. 1–Mar. 10.[21a]

Prohibited methods: Unlawful to use pitfall, deadfall, scaffold, cage, snare, trap, net, pen, baited hook, or baited field or any other similar device, or any drug, poison, chemical, or explosive for taking animals protected by State laws, except muskrat, skunk, mink, and otter. Traps or other devices unlawfully set are subject to confiscation. Unlawful to destroy the nest, den, or lair of any animal protected by law. Unlawful to hunt, kill, take, or destroy any protected animal, except muskrat, skunk, mink, and otter, while the ground is covered with snow. Unlawful to shoot at or destroy any fox while it is being chased by a dog. Muskrats may not be taken during the time any flood or freshet may cause them to leave their usual places of shelter and protection, nor may they be shot at night, hunted with a dog, or taken by the method commonly known as "nailing."

Licenses: License not required of resident; hunting license required of nonresident (fee, $10.50); issued by commission.

Possession and sale: Unlawful to sell fox or fox hide. No other restrictions.

Shipment and export: Unlawful to export fox or fox hide. No other restrictions.

Propagation: No restrictions, provided a permit is obtained from the Chief Game Warden (fee, $1). A limited number of wild fur or game animals for propagating purposes may be taken under permit.

Bounties: None paid.

DISTRICT OF COLUMBIA.

No legislation relating to fur animals.

FLORIDA.

Open seasons:	*Dates inclusive.*
Beaver, otter	Nov. 1–Jan. 31.
Other fur animals	Unprotected.

Prohibited methods: No restrictions.

Licenses: Resident, $1; nonresident or alien, $25; issued by county judge. Permission of owner required to trap on inclosed land of another.

Possession and sale: No restrictions.

Shipment and export: No restrictions.

Propagation: No legislation.

Bounties: None paid.

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[20] *Connecticut:* Fox, skunk, raccoon, wildcat, mink, or weasel may be hunted or trapped on State game preserves only by superintendent of fisheries and game or persons designated by him. Fur animals may be killed at any time for protection of property.

[21] *Delaware:* Owners may kill foxes at any time when destroying their poultry, and other fur animals may be killed at any time when destroying property.

[21a] In New Castle County, on embanked meadows, muskrats may be taken from December 1 to March 20.

GEORGIA.

(Laws 1921 not received.)

Open seasons: *Dates inclusive.*

Beaver, mink, otter, bear,[21b] skunk, opossum, muskrat,[21c] raccoon, fox (red, gray), wild cat,[21b] civet cat (see exception).......Nov. 20–Mar. 1.

Exception: Fox in Greene County (with dogs only).......Sept. 2–Jan. 31.

Licenses: Hunting license required to trap: Resident, State license, $3; county license, $1; nonresident, State license, $15; issued by commissioner or county warden. License not required to trap in militia district or on own or leased land during open season. Permission of owner required to trap on lands of another.

Possession and sale: Prohibited during close season.

Shipment and export: No restrictions.

Propagation: No restrictions on propagation of unprotected fur animals.

Bounties: None paid.

HAWAII.

Hawaii has no wild animals valuable for fur. There are no restrictions on the propagation of fur animals, except that mongooses and rabbits may not be kept or bred. Pet rabbits may be raised if kept in confinement.

IDAHO.

Open seasons:[22] *Dates inclusive.*

Otter, mink, muskrat, raccoon.......Dec. 1–May 1.[23]

Marten, fisher, fox.......Oct. 1–Feb. 1.

Bear, mountain lion, wolf, coyote, lynx, bobcat, jack rabbit, skunk, weasel (see exception).......Unprotected.[23]

Exception: Bear[22] in Benewah, Bonner, Boundary, Kootenai, and Shoshone Counties.......Sept. 16–May 30.

Beaver.......No open season.[24]

Prohibited methods: No restrictions.

Licenses: Resident, $5; nonresident, $25; alien, $50; issued by warden, deputy, or authorized agent. No license required of veterans of Civil War or of children under 12 years of age. Licensed trapper must make verified report at end of season of number and kind of fur caught, where sold, and the price received. Unlawful to destroy, disturb, or remove traps of licensed trapper.

Possession and sale:[24] Skins of animals legally taken, within or without State, may be possessed or sold at any time. Unlawful to possess fur animals, or the hides thereof, on which there is no open season in the State, without permit from State game warden.

Shipment and export: No restrictions.

Miscellaneous: Unlawful to use flesh of any game animal for trap bait. Unlawful to destroy houses, dams, or other structures erected by fur animals, except under permit of State warden.

Propagation: Permit from State warden required. Permittee must make verified yearly report showing number of animals kept in captivity, number sold, and number on hand.

Bounties: Coyote, lynx, or wildcat, $2.50 each; bear or wolf, $20; mountain lion, $50; paid from predatory wild animal fund.

[21b] *Georgia:* Bear and wildcat may be hunted at any time for sport by holders of State hunting licenses except that a license is not required in own militia district.

[21c] Fur animals destroying property may be killed at any time, and muskrats damaging cultivated or pasture lands or dams may be killed under permit from department of game and fish.

[22] *Idaho:* Fish and Game Warden may close season in any locality on any species of fur-bearing animal threatened with extinction. Under permit of State warden, person may protect own premises from depredations of fur animals, except that bears doing damage may be destroyed without a permit.

[23] In Black Lake Game Preserve beaver, otter, marten, fisher, fox, mink, and wolverine are protected at all times; mountain lion, bear, lynx, wolf, coyote, and wildcat may be destroyed only by game wardens or duly authorized persons.

In Payette Game Preserve bear, lynx, wolverine, fox, otter, beaver, marten, mink, and fisher are protected at all times; mountain lion, timber wolf, coyote, and wildcat may be killed only by game wardens or duly authorized persons.

In Selway and Big Lost River Game Preserves beaver, otter, marten, fisher, fox, and mink are protected at all times; mountain lion, bear, lynx, wolf, coyote, wolverine, and wildcat may be killed only by game wardens or duly authorized persons. In Big Lost River Preserve badger, weasel, skunk, and rabbit may be killed by anyone without permit.

In Big Creek Game Preserve beaver, otter, marten, fisher, fox, and mink are protected at all times; mountain lion, lynx, timber wolf, coyote, and wildcat may be killed only by game wardens or duly authorized persons.

[24] State warden may grant permits to take beaver when doing damage to irrigation canals, crops, etc. Pelts of animals taken must be turned over to warden for sale, half the proceeds going to the trapper. Possession of beaver hides otherwise prohibited.

ILLINOIS.

Open seasons:[26]	*Dates inclusive.*
Raccoon, mink, muskrat, skunk, opossum, fox, otter	Nov. 1–Mar. 15.
Other fur animals	Unprotected.

Prohibited methods: Unlawful to use spear or similar device for hunting or taking fur-bearing animals or explosives, chemicals, or mechanical devices or smokers of any kind to drive them out of their burrows, dens, or houses. Use of automobile or vehicle propelled by mechanical power, or the lights thereof, or ferret in hunting or taking fur-bearing animal prohibited.

Licenses: Resident, $1; nonresident, $10.50; issued by county, city, or village clerk. License not required of landowners and tenants and members of families to trap during open season on the lands on which they reside. License not issued to person under 16 years of age without written consent of parent or guardian, nor to alien. Licensee, on or before April 15, must report all hides of fur animals taken, sold, shipped, or dealt in, together with names and addresses of persons to whom sold or shipped. Permission from owner, agent, or occupant required to trap on land of another.

Possession and sale: Possession of green hides prohibited except from November 1 to March 25. No other restrictions on possession and sale.

Shipment and export: No restrictions on skins legally taken and possessed.

Propagation: Permit required to conduct a fur farm on which protected animals are reared; fee, $2.

Bounties: None paid by State; counties may pay bounty on groundhog and crow.

INDIANA.

Open seasons:[27]	*Dates inclusive.*
Raccoon, fox, opossum, skunk, mink, muskrat	Nov. 10–Feb. 10.
Beaver, otter	No open season.

Prohibited methods: Traps set on land of another must be placed at least 18 inches within burrow or hollow log and must be visited at least once in each 36 hours. Muskrat houses protected except when obstructing ditches or watercourses. Unlawful to dig out fur-bearing animals or to chase them from their burrows by use of smoke, fumes, or chemicals.

Licenses: None required of residents; nonresident, $15.50; issued by clerk circuit court. Written consent of owner, occupant, or lessee required to trap on land of another.

Possession and sale: Possession of fur animals or green hides prohibited during close season, except that fresh skins may be disposed of during first 5 days of close season. No other restrictions.

Shipment and export: No restrictions on skins legally taken and possessed.

Propagation: All animals raised in captivity are considered domestic stock, and the owner may possess, sell, ship, transport, or otherwise dispose of them without regard to laws regulating the killing and disposition of wild animals. An inspection certificate, fee $10, must be obtained from the Department of Conservation. Permit required to possess or harbor ferrets; fees, $10 for each single ferret and $5 for each additional one; issued by Conservation Department.

Bounties: Boards of county commissioners may pay bounty on wolf, fox, woodchuck, crow, owl, or hawk.

IOWA.

Open seasons:[28]	*Dates inclusive.*
Beaver, mink, otter, muskrat	Nov. 15–Mar. 15.
Raccoon	Oct. 15–Feb. 1.
Other fur animals	Unprotected.

Prohibited methods: No restrictions.

Licenses: Hunting license required to trap: Resident, $1; nonresident, $10, issued by county auditor. License not issued to person under 18 years of age without written consent of parent or guardian. Owners of farm lands, their children, and tenants may trap on own land without license during open season. Permission of owner, occupant, or agent required to hunt fur animals with dog or gun on cultivated or inclosed land of another.

Possession and sale: Possession and sale of beaver, mink, otter, and muskrat prohibited except during open season and first 5 days of close season.

Shipment and export: Export of protected fur animals prohibited.

Propagation: No restrictions except as to possession of protected species.

Bounties: Boards of supervisors of counties may allow bounty on crow, groundhog, pocket gopher, or rattlesnake.

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[26] *Illinois:* Houses and dens of fur-bearing animals protected except when obstructing public or private ditches or watercourses.

[27] *Indiana:* Protected fur animals may be killed at any time on one's own premises to protect property. The destruction of such animals, however, must be reported to the Department of Conservation within 5 days, and if hides are preserved, they must be sent to the department or arrangements made for their disposition.

[28] *Iowa:* Fur animals may be destroyed at any time to protect public or private property.

KANSAS.

Open seasons:	*Dates inclusive.*
Muskrat, skunk, mink, raccoon, opossum, civet cat	Dec. 2–Feb. 28.[30]
Beaver, otter	No open season.
Other fur animals	Unprotected.

Prohibited methods: Ferrets, poisons, or use of smoke guns or other devices for forcing smoke, gas, or liquids into holes, dens, or runways, prohibited. Unlawful to destroy houses, dens, or runways of fur animals.

Licenses: Resident, $1; issued by county clerk. Resident landowner and members of his family may hunt or trap on own land during open season without license. Trapping license not issued to nonresident or alien. Consent of owner or lessee required to hunt or kill wild animals on land of another.

Possession and sale: No restrictions on skins legally taken.

Shipment and export: No restrictions on skins legally taken.

Propagation: Quadrupeds raised in wholly inclosed preserve under license (fee $2) may be sold at any time for breeding or stocking purposes. Shipments must be tagged to show number and kind of animals, number of breeder's license, names and addresses of consignor and consignee, and be accompanied by permits from State warden. Licensee required to make annual report of number of animals in possession. Wild animals may be captured during open season and thereafter had in possession for breeding purposes, under rules and regulations of State warden.

Bounties: Coyote, $1; wolf, $5; crow and pocket gopher, 5 cents each; paid by county.

KENTUCKY.

Open season:[31]	*Dates inclusive.*
Beaver, mink, raccoon, fox, otter, opossum, skunk	Nov. 15–Dec. 31.[32]
Other fur animals	Unprotected.

Prohibited methods: Traps must be set 18 inches or more within a hole, cave, or hollow log, and must be visited within each 36 hours.

Licenses: None required. Written consent of owner or lessee required to trap on lands of another.

Possession and sale: Possession of green skins during close season prima facie evidence of unlawful taking.

Shipment and export: No restrictions on skins legally taken.

Propagation: No legislation.

Bounties: None paid.

LOUISIANA.

Open seasons:	*Dates inclusive.*
Bear[33]	Nov. 1–Feb. 15.
Muskrat, mink, otter, raccoon, skunk, fox, opossum	Nov. 1–Jan. 31.[34]
Beaver	No open season.
Wolf, fox, wildcat, cougar	Unprotected.[35]

Prohibited methods: Unlawful to trap bear. No other restrictions.

Licenses:[35] Trapping (includes privilege of hunting), $1; buyers, $5; resident dealers, $25; nonresident dealers, $50; issued by tax collector. Nonresident[33] not permitted to trap.

Possession and sale: Skins legally taken may be possessed, sold, and shipped at any time.

Shipment and export: All shipments must bear tags furnished by commissioner; no furs nor alligator skin may be shipped out of State except by holder of a dealer's license; export of beaver taken in State prohibited; also of bear, except under written permission of the commissioner.

Miscellaneous: Use of birds for trap bait prohibited.

Propagation: Fur animals for breeding purposes may not be captured except under restrictions specified in permits issued by Department of Conservation. Permit from the department is required to import wild quadrupeds into the State or to export them from the State.

Bounties: None paid.

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[30] *Kansas:* Owner or legal occupant of land may destroy these animals at any time when they are destroying poultry or damaging other property.

[31] *Kentucky:* Fur animals may be killed at any time on one's own premises to protect property.

[32] Raccoon, opossum, skunk, and mink may also be taken with gun or dog from Oct. 1 to Feb. 15.

[33] *Louisiana:* Bears may be killed at any time on one's own land when actually damaging property. Nonresidents coming into State to hunt bears required to report in writing to Department of Conservation on or before arrival at destination.

[34] Muskrats may be killed at any time when damaging any levee, and, under permit of Department of Conservation, to prevent damage to cultivated or pasture land; any fur animal may be killed by the owner of land upon which it is destroying property.

[35] Wolves, foxes, and wildcats hunted for sport may be taken in any manner at any time, and may be possessed by the lawful holder of a State hunting license.

MAINE.

Open seasons: [36]	*Dates inclusive.*
Muskrat	Oct. 15–May 14.[37]
Raccoon	Sept. 1–Feb. 28.
Beaver	No open season.[38]
Bear, bobcat, Canada lynx (loup cervier), weasel	Unprotected.
Other fur animals	Oct. 15–Feb. 28.[37]

Prohibited methods: Unlawful to use snare, swivel, pivot, or set gun, or to put out poison for any animals. Traps may not be set within 25 feet of a muskrat house. Unlawful to dig out a fox den. Owner's name and address must either be plainly stamped on the trap or on a metal tag firmly attached to it. A bear trap must be inclosed in a "hut," or surrounded with two strands of barbed wire, 5 yards distant from the trap, 4 and 5 feet, respectively, from the ground. Muskrat and beaver houses must not be disturbed.

Licenses: Required to trap fur animals (except bear and bobcat) in unorganized townships: Fee, $10; issued by commissioner. Licensee, on or before December 15 of each year, must make such report as the commissioner may require. Written consent of the owner or occupant must be obtained before setting traps on the lands of another in an organized county or incorporated place; such traps must be visited at least once in every 24 hours and any animals caught removed.

Special beaver-trapping license, good only in territory opened to beaver trapping by commissioner, fee, $25. Dealer in skins must be licensed (fee, State, $25; county, $2), and must keep a record of transactions and forward same to the commissioner of inland fisheries and game on or before December 20 of each year.

Possession and sale: Sale of beaver skins without seal of commissioner attached prohibited. No other restrictions on skins legally taken.

Shipment and export: Transportation of beaver skins without seal of commissioner attached prohibited. No other restrictions on skins legally taken.

Propagation: Permit required to raise fur animals (fee, $2). Protected species may be taken under special permits by licensed trappers for breeding purposes. No animals may be imported into the State without permit.

Bounties: Bobcat and Canada lynx (loup cervier), $10 each; paid by State; claim to be made within five days after killing or return from trip on which killing was done. Bear, $5 ($10 in Washington and Penobscot counties); paid by State; claim to be made within 10 days after killing.

MARYLAND.

Open seasons:	*Dates inclusive.*
Otter, muskrat	Jan. 1–Mar. 15.

Other fur animals unprotected (except locally, as follows):

Raccoon:

In Allegany County, Sept. 1–Mar. 31; in Anne Arundel and Prince Georges Counties, Oct. 1–Jan. 31 [39]; in Baltimore county, Oct. 1–Feb. 28 [40]; in Caroline County, Sept. 15–Mar. 31; in Dorchester County, Nov. 10–Mar. 15; in Harford County, Oct. 2–Nov. 30; in Kent, Queen Anne, Somerset, and Wicomico Counties, Jan. 1–Mar. 31; in Montgomery County, Oct. 15–Jan. 14.

Opossum:

In Allegany County, Sept. 1–Mar. 31; in Baltimore County, Oct. 1–Feb. 28 [40]; in Montgomery county, Oct. 15–Jan. 14; in Washington County, Dec. 1–Mar. 31.

Mink: In Washington County, Dec. 1–Mar. 31; in Worcester County, Dec. 15–Mar. 1.[41]

Skunk: In Washington County, Dec. 1–Mar. 31.

Fox:

In Caroline County, no open season; [42] in Carroll County, no open season; [42] in Worcester County (chase with dogs), Sept. 1–Mar. 9.

All fur animals (except as above mentioned):

In Frederick County, Nov. 15–Feb. 28; [43] in Harford County (trapping), Nov. 15–Dec. 24.

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[36] *Maine:* Any person may lawfully kill any wild animal, except beaver, found destroying his property.

[37] Special laws on muskrat, otter, fisher, and mink in certain localities in Oxford and Washington Counties. For information apply to Commissioner of Inland Fisheries and Game, Augusta.

[38] Commissioner of inland fisheries and game, upon written complaint of landowner that beavers are doing substantial damage to his property, may declare special local open season on them (*see* "Licenses").

[39] *Maryland: Anne Arundel and Prince Georges Counties.*—Raccoon may not be taken between sunrise and sunset.

[40] *Baltimore County.*—Unlawful to set traps, except from Nov. 10 to Dec. 20, for mink, weasel, skunk, raccoon, opossum, or fox. Permits to take certain predatory fur animals when destroying property may be obtained.

[41] *Worcester County.*—Unlawful to take mink on land of another without permission of owner.

[42] *Caroline and Carroll Counties.*—Unlawful to kill a fox except by hounds in a hunt or when the fox is destroying poultry.

[43] *Frederick County.*—Raccoons or opossums may be hunted with dogs at night at any time. Landowners may protect property from ravages of fur animals.

Prohibited methods: Unlawful to take or kill otter or muskrat in any manner, except by gigging or trapping; to dig for muskrat or in any manner molest or destroy any part of a muskrat house or den. County restrictions as follows:

Anne Arundel County.—Unlawful to cut down tree to obtain a raccoon.

Baltimore County.—Unlawful to hunt raccoon or opossum on Sunday or when snow covers the ground.

Licenses: Hunting license required to trap: Resident, State, $5.10; county, $1.10; nonresident, $10.25 (fee $5.25 for State license if applicant owns real estate in Maryland assessed at $500; $1.25 for county license in county where such real estate is located); issued by clerk of circuit court—in Baltimore City by clerk of court of common pleas. License not issued to person under 14 years of age without written request of parent or guardian. Owners, tenants, and their children may hunt on own land during open season without license.

Possession and sale: Possession of green hides of otter or muskrat prohibited except from January 1 to March 25. No other restrictions on possession and sale of skins legally taken. County restrictions as follows:

Allegany and Baltimore Counties.—Possession of raccoon and opossum prohibited during close season.

Anne Arundel and Prince Georges Counties.—Possession of raccoon during close season prohibited.

Harford County.—Sale of raccoon for export from county prohibited.

Shipment and export: No restrictions on skins legally taken and possessed, except that raccoons may not be removed from Harford County.

Propagation: No legislation.

Bounties: A State bounty of 50 cents each on bird hawk, or chicken hawk, killed in State, paid from State game protection fund. *Garrett County:* Wild cat, $4; fox, $2; paid by county treasurer.

MASSACHUSETTS.

Open seasons:[44]	*Dates inclusive.*
Mink, otter, skunk, raccoon (see exception)	Nov. 1–Mar. 1.
Exception: Raccoon may also be hunted with dog and gun during October.	
Muskrat	Nov. 1–Apr. 10.[44]
Other fur animals	Unprotected.

Prohibited methods: Unlawful to open, disturb, or destroy muskrat house or to set trap within 10 feet thereof. Traps must be marked legibly with owner's name and must be removed at end of open season. Poison may not be used to kill animals, except rats, woodchucks, or other pests on one's own premises. The use of steel traps with spread of over 6 inches and "choke" traps with greater opening than 6 inches is unlawful, as is also the use of snares or, except with consent of landowner, of scented baits. Except as otherwise stated, fur animals may only be taken by shooting or trapping.

Bag limits: Twenty-five raccoon a season.

Licenses: Hunting license required to trap: Resident citizen, $1 (1922, $1.50); nonresident citizen, $10; alien, $15 (alien applicant must own real estate to the assessed value of $500); issued by city or town clerks. License not issued to minors under 15 years of age and those under 18 must apply in writing and furnish written consent of parent or guardian. License (fee, 25 cents) to trap quadrupeds, in discretion of issuing officer, may be issued to any citizen between the ages of 12 and 18. License not required of resident on own land used exclusively for agricultural purposes and on which he is actually domiciled. The following nonresidents pay a fee of $1: Members of incorporated game clubs owning real estate assessed at not less than $500 for each member and which were organized prior to 1907; owners, or their minor children over 18 years of age, of real estate assessed at not less than $500; or nonresidents invited (for not more than four days) by members of incorporated clubs for hunting foxes.

Written consent of owners required to trap on improved or posted land of another. Traps must be visited at least once in 24 hours. Animals may be removed from traps on Sunday, but traps may not be set or reset on such day.

Possession and sale: No restrictions on skins legally taken during open season.

Shipment and export: No restrictions on skins legally taken during open season.

Miscellaneous: Introduction of fox or raccoon in Dukes County prohibited.

Propagation: May be permitted under regulations of division of fisheries and game.

Bounties: Seal, $2 (by Commonwealth); wildcat or lynx, $5; paid by town, but refunded by county.

MICHIGAN.

Open seasons:[45]	*Dates inclusive.*
Beaver	No open season.[45]
Otter, mink, fisher, marten, raccoon, skunk, muskrat	Nov. 1–Mar. 31.
Bear, wolf, coyote, fox, lynx, wildcat	Unprotected.

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[44] *Massachusetts:* Fur animals unprotected in Dukes and Nantucket Counties; muskrats may be taken with trap after March 1.

[45] *Michigan:* Beaver season closed until 1925. Houses or dams of fur animals protected at all times. Fur animals, except beaver, may be destroyed under permit from commissioner, on one's own premises to protect property, but hides must be properly cared for and turned over to commissioner at expiration of permit. Unlawful to trap on State game preserves or to trap beaver, badger, or muskrat, in and within 2 miles of any city public park containing over 200 acres, of which 150 acres or more is woodland.

Prohibited methods: Unlawful to use spears, explosives, chemicals, mechanical devices, or smokers to drive animals from their holes or homes; to destroy, disturb, or molest any beaver, skunk, or muskrat houses or holes; to shoot muskrats except with a .22 caliber rifle, or to set a trap within 6 feet of a muskrat house or hole.

Licenses: Resident, $1; nonresident, $10; issued by county clerk. A hunting license also permits the holder to trap fur-bearing animals, except beaver. Minor children under 17 years of age may hunt or trap during open season on the enclosed lands of their parents upon which they live, without a license. License to hunt or trap on other lands issued to minors over 12 and under 17 on application of parents or guardian, but such licensed minors while hunting or trapping must be accompanied by parent or guardian. Alien prohibited from hunting or taking any wild animal in State.

Possession and sale: Possession of the carcass or skin of fur animals killed in close season prohibited.

Shipment and export: No restrictions on skins legally taken, possessed, or tagged.

Propagation: Annual license (fee, $5) required to engage in raising fur animals. Live animals and skins of animals raised in captivity must be tagged (fee, 5 cents for each tag).

Bounties: Woodchuck, crow, 25 cents; paid by county, one-half refunded by State.

Counties, cities, villages, and townships may pay bounties for the destruction of injurious animals and birds.

MINNESOTA.

Open seasons:	*Dates inclusive.*
Raccoon	Oct. 15–Mar. 1.
Mink, fisher, marten, muskrat	Dec. 1–Apr. 1.[46]
Beaver,[47] otter	No open season.
Black bear, skunk, weasel, wolf, wildcat, lynx, fox	Unprotected.

Prohibited methods: Unlawful to molest or destroy muskrat, mink, or beaver house, den, dam, or abiding place; to hunt these animals with dogs; or to take muskrats in any manner except by trapping.

Licenses: Resident only fee, $1; issued by county auditors; commissioner may issue licenses (fee, $1, bond, $500) to trap a limited number of beaver in any locality; licensee must report number of beaver taken within 5 days after expiration of license. Owners, lessees, or members of their immediate families may hunt without license during open season on own or leased land occupied by them as permanent residence. Unlawful to enter growing grain for purpose of killing any wild animal without permission of owner.

Possession and sale: Skins of beaver legally taken, when tagged (fee, $3), and skins of other fur animals legally taken, may be possessed, bought, or sold at any time.

Shipment and export: Skins of beaver legally taken, when tagged (fee, $3), and other skins legally taken may be transported at any time. Export of red fox cubs taken in State prohibited. Package or receptacle containing wild animals or parts thereof when transported by a common carrier must have attached a proper coupon tag bearing signature, address, and license number of shipper, together with number and kinds of animals or parts thereof contained therein.

Propagation: Wild animals raised in captivity under a $1 permit from the State game and fish commissioner may be sold for breeding or stocking purposes at any time, and under regulations of the commissioner may be killed and any part thereof sold or transported. Under regulations of the commissioner, wild animals may be captured for breeding purposes.

Bounties: Wolf, $7.50; cub wolf, $3; paid by State. County or town boards may offer bounty on wolf, gopher, ground squirrel, groundhog, rattlesnake, crow, or blackbird.

MISSISSIPPI.

Open seasons:	*Dates inclusive.*
Bear	Nov. 15–Mar. 1.
Other fur animals	Unprotected.

Prohibited methods: Unlawful to trap bear.

Licenses: Nonresident, $20 (county license, bears only); issued by sheriff. Landowners and their nonresident relatives and friends may hunt without license during open season on own lands.

Possession and sale: Sale of bears prohibited.

Shipment and export: Export of bears prohibited. All packages containing dead animals, or parts thereof, shipped within the State shall be open to view, clearly marked with names of the consignor and consignee, and an itemized statement of the number of each species.

Propagation: No legislation.

Bounties: None paid.

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[46] *Minnesota:* Owner may obtain permit to kill muskrat, mink, or beaver or to destroy their houses or dams when damaging his property.

[47] A limited number of beaver may be taken under a special license from the commissioner (*see* "Licenses").

MISSOURI.

Open seasons:	*Dates inclusive.*
All fur animals	Nov. 1-Jan. 31.[48]

Prohibited methods: Use of poison in taking any protected animal prohibited.

Licenses: None required. Written permission required to trap on inclosed premises of another.

Possession and sale: Unlawful to possess, sell, or offer for sale pelts of fur animals taken out of season.

Shipment and export: No restrictions, except that furs taken out of season may not be possessed for any purpose.

Propagation: Permits to capture fur animals for propagating purposes may be obtained from the State game and fish commissioner, fee, $5; breeder's permit, fee, $5.

Bounties: Adult wolf or coyote, $6; young wolf or young coyote, $3; paid by county and one-half refunded by State.

MONTANA.

Open seasons:	*Dates inclusive.*
Marten, fisher, otter, sable, fox, muskrat	Nov. 1-Apr. 1.
Beaver	No open season.[49]
Other fur and predatory animals	Unprotected.

Prohibited methods: No restrictions.

Licenses: Marten, $1; other fur animals (except beaver and predatory animals), $2; special permit to trap beaver or to sell or ship their skins required; special license (trapping on State game preserves), $5; issued by State game warden. Trapping license not required of minors under 15 years of age.

Possession and sale: Sale and shipment of beaver skins prohibited, except that skins legally taken may be shipped or sold under permit from the State game warden by the persons killing the animals, but permittees must report name of purchaser and number of skins sold. No other restrictions on skins legally taken.

Shipment and export: (*See* Possession and sale.) No restrictions on skins legally taken, possessed, or tagged.

Propagation: No legislation.

Bounties: Grown wolf, $15; wolf pup, coyote, or coyote pup, $2.50; mountain lion, $10; paid from State bounty fund.

NEBRASKA.

Open seasons:	*Dates inclusive.*
Muskrat, otter, mink, fox, raccoon, opossum	Nov. 1-Feb. 15.[50]
Beaver	No open season.[51]
Other fur animals	Unprotected.

Prohibited methods: Unlawful to use spear or like device in hunting or taking fur animals, or explosives, chemicals, mechanical devices, or smokers of any kind, or ferrets to drive fur aninals from holes, dens, or houses. Unlawful to disturb or destroy den or house of fur animal, except of muskrat or otter obstructing a public or private ditch or water course: unlawful to cut down or into any tree containing a den.

Licenses: Resident, $2.10; nonresident or alien, $25.10; buyer, $1; issued by State Department of Agriculture and authorized vendors.

Possession and sale: Possession of green hides prohibited, except from November 1 to February 25. Beaver skins coming from without the State, upon being inspected and stamped by State Warden, may be possessed and sold at any time. No other restrictions on skins legally taken.

Shipment and export: Green hides may be transported by express, baggage, or mail from November 1 to February 25 if package is labeled (in two places) with name of consignor, number of his trapping license, and number and kind of hides.

Propagation: Fur animals raised in captivity under $2 breeding license may be sold alive and transported for breeding purposes, and the skins, when tagged and labeled with name of licensee, number of license, and kind and number of skins, may be sold and transported at any time.

Bounties: Counties that have voted at any general election to pay bounties may pay for wolf, $6; coyote, $3; mountain lion, $3, wildcat, $1.

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[48] *Missouri:* Fur animals may be destroyed at any time and in any way to protect premises from their depredations, and pelts of animals so killed may be marketed.

[49] *Montana:* Unlawful to kill beaver, except under a special license from the State game warden, but taxpayers, owners of real estate in the State, or their authorized agents may kill beaver on their own premises for the protection of their ditches, dams, etc.; such killing must be reported in writing to the State game warden within 30 days.

[50] *Nebraska:* Fur animals, except beaver, may be taken at any time when necessary for the protection of property.

[51] Beaver damaging property may be killed on own land under a permit from Chief Game Warden, but pelts of animals so taken must be sent to State Department of Agriculture for disposition, half of proceeds to be returned to permittee.

NEVADA.

Open seasons:

Beaver,[51a] otter	No open season.
All other fur animals	Unprotected.

Prohibited methods: No restrictions.

Licenses: None required.

Possession and sale: Unlawful to possess beaver or otter skins unless it can be shown that they were legally taken. No other restrictions.

Shipment and export: Permit required to export beaver or other furs.

Propagation: Game or fur animals (except beaver) raised in a licensed preserve (fee, $10) may be sold or shipped at any time under invoice.

Bounties: Mountain lion, $5; lynx or wildcat, $2; paid by county. Counties pay bounty of 1½ cents each for pocket gophers when at least 100 heads are presented at one time.

The State board of live stock commissioners is authorized to pay bounty from funds derived from tax on horses, cattle, and hogs. The rewards for coyote, coyote pup, wildcat, or lynx are 75 cents each; for mountain lion, $5.

The State board of sheep commissioners is authorized to pay bounty from funds derived from tax on sheep, the payments being the same as those made by board of live stock commissioners.

NEW HAMPSHIRE.

Open seasons:[52]	*Dates inclusive.*
Sable, otter, fisher, mink, marten, muskrat,[53] skunk, fox[54] (see exception)	Nov. 1–Feb. 28.
Exception: In Carroll, Coos, and Grafton Counties	Oct. 10–Feb. 28.
Raccoon	Nov. 1–Dec. 31.[54]
Beaver	No open season.
Other fur animals	Unprotected.

Prohibited methods: Bear traps must be safeguarded in a substantial manner. Use of set guns or snares is prohibited. Unlawful to destroy a muskrat house or set a trap therein, thereon, or at the entrance thereof.

Licenses: Resident, $1; nonresident, $15; issued by commissioner or agents. License not required of resident landowners and their minor children to trap on own farm lands during open season. No person may trap on lands of which he is not the owner or lessee without permission of owner. All metal traps must be legibly marked or stamped with trapper's name, and must be visited at least once every 24 hours. Unlawful to take traps of another or to remove fur animals from them. Trappers are liable for any damage to domestic animals by traps.

Possession and sale: Possession of fur animals permitted only during open season, but skins legally taken may be bought or sold at any time.

Shipment and export: No restrictions on skins legally taken and possessed.

Miscellaneous: Unlawful to tear down or destroy any fence or wall, leave open any gate or bar, or trample, or destroy any crop on land of another while trapping or pursuing wild animals.

Propagation: Permit (fee, $2) required to propagate fur animals, game, or fish.

Bounties: Bear, $5; hedgehog, 20 cents; wildcat, $10; paid by State, through the selectmen of towns.

NEW JERSEY.

Open seasons:	*Dates inclusive.*
Skunk, mink, muskrat,[55] otter	Nov. 15–Apr. 1.
Raccoon	Oct. 1–Dec. 15.
Beaver	No open season.[56]
Other fur animals	Unprotected.

Prohibited methods: Muskrat, skunk, mink, and otter may be taken by trap only, except in Salem County, above Mill Creek, where they may be taken in open season by firearms and light. Unlawful at any time to disturb the lodge or nesting chamber of muskrat.

Licenses: No trapping license required. Hunting license required in Salem County by those using firearms; fees, resident male citizen above age of 14, $1.15; nonresident, $10.15. Aliens (except those who own real estate in the State to the value of $2,000 above all encumbrances) not permitted to hunt, capture,

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[51a] *Nevada:* Beaver doing damage to property may be trapped under authorization from the board of county commissioners. Furs of animals so taken must be preserved and turned over to the board for sale, half of the proceeds to be returned to the trapper.

[52] *New Hampshire:* Fur or predatory animals may be killed at any time when destroying domestic animals or fowls.

[53] Muskrats may also be taken from the waters of the Connecticut River during the month of March.

[54] Raccoons and foxes may also be taken by use of dog and gun during the month of October.

[55] *New Jersey:* Muskrats may be killed at any time by owner of canal or dam which they are destroying.

[56] Foxes may be hunted with hounds and firearms in daylight at any time, except during open season for deer (Dec. 16–Dec. 20). Killing of fox must be reported to commissioners or county warden within 48 hours.

Licenses: Continued.
or kill any wild animal, except in defense of person or property, and may not own or possess a shotgun or rifle. Aliens qualified to hunt must secure nonresident license

Possession and sale: Possession of raccoon permitted during open season and 10 days thereafter; skins legally taken may be possessed or sold at any time. Possession of live fox prohibited except by permission of board of fish and game commissioners.

Shipment and export: Export of raccoon prohibited, except by nonresident license. No other restrictions on skins legally taken or possessed

Miscellaneous: Unlawful to molest traps set by another or to take animals caught in such traps. Unlawful to liberate fox in State.

Propagation: No restrictions except those imposed by close seasons, during which wild animals may not be taken for breeding purposes.

Bounties: Fox, $3; woodchuck, amount, not exceeding 50 cents, fixed by board of chosen freeholders; paid by counties.

NEW MEXICO.

Open seasons:

Beaver	No open season.[57]
All other fur animals	Unprotected.

Prohibited methods: No restrictions.

Licenses: None required.

Possession and sale: No restrictions on skins legally taken.

Shipment and export: No restrictions on skins legally taken.

Propagation: Permit from State game warden required.

Bounties: Coyote, wildcat, or lynx, $2; wolf, $15; panther or mountain lion, $10; paid from county wild-animal fund.

NEW YORK.

Open seasons:

	Dates inclusive.
Mink, sable	Nov. 10–Mar. 15.
Skunk	Nov. 10–Feb. 10.[58]
Muskrat (see exception)	Dec. 1–Mar. 31.
Exception: In Clinton, Essex, Franklin, Hamilton, Jefferson, Lewis, St. Lawrence, Warren, Washington, and that portion of Herkimer County north of the towns of Ohio and Russia	Dec. 1–Apr. 20.
Raccoon	Nov. 10–Feb. 10.
Beaver	No open season.

Prohibited methods: Skunks may not be taken by the aid of dogs or by digging out or driving them from dens or holes by smoking or by the use of chemicals. Unlawful to kill muskrats by shooting, except they may be taken with a 22-caliber rifle in the counties bordering upon Lake Champlain; to take them in box, wire, or cage traps; or to molest, injure, or disturb muskrat houses or dens.

Licenses: Resident, $1.10; nonresident, $10.50; issued by county, city, or town clerks. Licensee required to wear button. Owners, tenants, and members of immediate families actually occupying cultivated farm lands may trap fur animals thereon without license during open season. Minors under 16 may trap fur animals without a license.

Possession and sale: Fur animals may be possessed during open season only, but hides of fur animals legally taken and possessed may be bought or sold at any time.

Shipment and export: Shipment and export prohibited, except hides of fur animals legally taken and possessed may be transported at any time.

Miscellaneous: Traps used for taking fur animals protected by law may not be staked or set during close season.

Propagation: Protected fur animals may be kept alive in captivity for propagation and sale, under license from the conservation commission (fee, $5). No fur-bearing animals may be kept which are taken wild during close season for such animals (unless taken under license); nor may they be disposed of during close season. The conservation commission is authorized to issue license to capture animals for propagation; fee for permit, $1.

Bounties: Panther, $20; paid by State.

NORTH CAROLINA.

[More than half of the 100 counties in the State have local laws relating to fur animals. Information regarding open seasons, license requirements, and trapping and hunting restrictions in the counties under the jurisdiction of the State Audubon Society may be obtained from the Secretary, Audubon Society of North Carolina, Raleigh.]

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[57] *New Mexico:* When destroying property beaver may be killed under permit from State game and fish warden.

[58] *New York:* If injuring property, skunks may be taken at any time and in any manner, but the skins of animals so taken shall not be possessed, sold, bought, or trafficked in.

NORTH DAKOTA.

Open seasons:	*Dates inclusive.*
Mink	Nov. 16–Apr. 14.[59]
Beaver, otter, muskrat	No open season.[60]
Other fur animals	Unprotected.

Prohibited methods: Unlawful to cut into, molest, destroy, or dynamite any beaver dam or beaver or muskrat house or mound.

Licenses: Resident, $2 (for mink); nonresident, $25 (for mink only); issued by commissioners, deputies, and county auditors. License not required of persons under 16 years of age, or of resident or member of family residing permanently with him, to trap on own cultivated land, during open season. Alien prohibited from hunting, taking, or killing any wild animal, except in defense of person or property.

Possession and sale: Skins of fur animals killed within or without the State may be possessed or sold at any time. Green hides of mink may be possessed only during open season and first 5 days of close season.

Shipment and export: Shipment and export prohibited, except skins of fur animals legally taken within or without the State may be shipped at any time.

Propagation: The State game and fish board issues permits (fee, $5) to breed and domesticate mink, muskrat, skunk, and raccoon, and also permits to sell or ship them when raised in captivity. Under permit from board and $500 bond, wild fur animals may be taken at any time for breeding purposes. Annual reports are required of licensed breeders.

Bounties: Wolf coyote, $2.50.

OHIO.

Open seasons:[61]	*Dates inclusive.*
Raccoon	Nov. 1–Feb. 1.
Muskrat, mink	Nov. 15–Mar. 1.
Fox, skunk, opossum	Nov. 15–Feb. 1.
Other fur animals	Unprotected.

Prohibited methods: Unlawful to dig out or destroy the house, den, or burrow of fur animals or to smoke or drown the animals therefrom.

Licenses: Resident, $1; nonresident, $15; issued by county and township clerks. Alien prohibited from hunting or trapping. License not required of owners, managers, tenants, or their children to trap during open season on own land. Written permission from owners or authorized agent required to trap on lands of another.

Possession and sale: Possession of fur animals during close season prohibited, but skins legally taken may be possessed or sold at any time. Raccoons legally taken may be possessed alive in inclosures as pets.

Shipment and export: Shipment and export prohibited, except that skins legally taken may be transported at any time. Packages containing fur animals or parts thereof when transported by common carrier must be marked to show contents, initial point of billing, and names and addresses of consignor and consignee.

Propagation: No restrictions, except those which prevent capture of wild stock in close season.

Bounties: Townships pay a bounty of $1 each on certain hawks and great horned owl; 20 cents a dozen on English sparrows; and, under certain conditions, 10 cents each on groundhogs.

OKLAHOMA.

Open seasons:	*Dates inclusive.*
Beaver, otter	No open season.
Bear (see exception)	Unprotected.
Exception: In Blaine, Caddo, Comanche, Kiowa, and Major Counties	No open season.
Other fur animals	Nov. 1–Mar. 1.

Prohibited methods: No restrictions.

Licenses: None required.

Possession and sale: Unlawful to sell pelts of fur animals taken during close season. No other restrictions.

Shipment and export: No restrictions on skins legally taken.

Propagation: The State game warden issues permits to propagate fur-bearing animals, game, and fish; cost, $2, together with fees for tagging. Licensed breeders may sell and transport animals raised in preserves under rules prescribed by the warden.

Bounties: County commissioners are authorized to offer bounty on gray wolf ($3) and coyote ($1), and may also pay bounties on hawks, crows, or other birds or animals destructive of game or insectivorous birds.

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[59] *North Dakota:* Mink may be killed at any time to protect one's own property.

[60] Expires January 10, 1924.

[61] *Ohio:* Protected fur animals, when damaging property, may be destroyed by owners or tenants of land (except on Sunday).

OREGON.

Open seasons:[62]	*Dates inclusive.*
Mink, otter, fisher, marten, muskrat,[63] raccoon	Nov. 1-Feb. 28.
Beaver [63]	No open season.
Other fur animals	Unprotected.

Prohibited methods: Unlawful to destroy muskrat house, except where it obstructs ditch or watercourse.

Licenses: Fee, $2; issued by State game commission. License not required for trapping on own land. Fur dealer, $3. Licensee must keep chronological record showing number and kind of furs purchased, and names and addresses of persons from whom obtained, and make verified annual report to commission Unlawful to remove or disturb traps of a licensed trapper on public domain or on land where he has permission to trap. Licensed trappers are required to make annual reports of number of animals caught, receipts for fur and where sold.

Possession and sale: Possession and sale prohibited, except that animals or hides legally taken within or without State may be possessed or sold at any time.

Shipment and export: Shipment and export prohibited, except skins of animals legally taken may be shipped at any time.

Miscellaneous: Unlawful to use the flesh of a game bird or animal for trap bait.

Propagation: Permits (fee, $2) to keep fur-bearing animals may be obtained from the State game commission. No wild fur-animals may be taken for propagating purposes in close season nor may those held in captivity under permit be sold in that season. Yearly reports to the commission are required.

Bounties: Coyote or coyote pup, $3; adult female coyote, $4; gray, black, or timber wolf, or wolf pup, $2.50; bobcat, wildcat, or lynx, $2. mountain lion, panther, or cougar, $10: seal or seal pup, $2.50; paid by county and half refunded by the State. The State game commission is empowered to pay additional bounties on any predatory animal in order to protect game: under this act it now pays for wolf, $20; for cougar, $15. Several counties are authorized to pay bounties on moles, rabbits, and gophers.

PENNSYLVANIA.

Open seasons:[64]	*Dates inclusive.*
Bear[65]	Nov. 1-Dec. 15.
Raccoon	Oct. 1-Jan. 31.
Muskrat, skunk, otter, mink, opossum	Nov. 1-Feb. 28.
Fox (see exception), wildcat, weasel	Unprotected.
Exception: Fox, in Chester and Delaware Counties	No open season.
Beaver	No open season.

Prohibited methods: Unlawful to take bears with steel trap, deadfall, or pen, or to shoot them except with a single bullet. Steel traps larger than No. 3 size may not be used for trapping wildcats or other animals classed as vermin. Unlawful to dig out fur animals: to drive them from holes or dens by use of smoke or chemicals; or to cut den trees.

Bag limits: One bear a season, or 3 to a camp or body of men.

Licenses: Nonresident, $10; resident (hunting license for raccoon or bear), $1 (fee of 15 cents extra to justice of peace); issued by commission, county treasurer, or justice of the peace. Hunting license not issued to minor under 14 years of age, and minor between 14 and 16 must furnish written consent of parent or guardian. Licensee required to wear tag on middle of back. Resident citizen and members of family residing on and cultivating land may hunt on such land, and, with consent of owner, on adjoining land, without a license, during open season. Alien not permitted to hunt or kill any wild animal in State, except in defense of person or property.

Possession and sale: Bear may be possessed only during open season and first 30 days of close season. Raccoon taken during open season may be possessed or sold at any time. Raw skins may be possessed during the open season and the first 15 days of close season.

Shipment and export: Raccoons legally taken may be shipped or exported at any time. Packages must be plainly marked to show contents, name and address of owner, and county in which taken. Shipment by parcel post prohibited. Nonresident licensee may take out 1 bear legally killed. No other restrictions on skins legally taken and possessed.

Propagation: No restrictions on raising fur animals, except that possession and breeding of ferrets is unlawful except under license from State board of game commissioners: fee for license to breed and sell ferrets, $25; to possess a ferret without breeding, $1.

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[62] *Oregon:* Unlawful to hunt or trap fur animals on State game preserve.

[63] If beavers or other fur animals damage property, permits to kill them may be obtained from the State game warden, but skins of animals so taken must be delivered to the State game commission for disposition.

[64] *Pennsylvania:* Fur animals may be killed by landowners or tenants and their employees at any time to protect their growing crops.

[65] Bear may be killed at any time in defense of person or property. The board of game commissioners, upon petition of 200 citizens of a county showing that bear have become a nuisance may permit them to be taken at any time, but steel traps and deadfalls may not be used. Animals so taken must be delivered to charitable institutions.

Bounties: Wildcat, $8; fox, $2; weasel, $1.50; paid from special fund created by setting aside one-half the receipts by the board of game commissioners from hunting licenses, fines, etc. Affidavit on form supplied by game commission must accompany entire unmutilated skin of animal when presenting claim to board of game commissioners, at Harrisburg, Pa.

PORTO RICO.

Porto Rico has no wild fur animals.

RHODE ISLAND.

Open seasons:[66]	*Dates inclusive.*
Skunk	Nov. 1–Apr. 15.
Raccoon	Oct. 1–Feb. 1.
Muskrat, mink, otter	Nov. 1–Feb. 1.
Other fur animals	Unprotected.

Prohibited methods: Unlawful to set wire snares, or to use steel traps with teeth or with spread over 6 inches, or choke traps with greater opening than 6 inches. Traps must be concealed so as not to endanger domestic animals and must be visited at least once every 24 hours.

Licenses: Hunting license required for trapping: resident, $1.25; nonresident, $10.25; alien, $15.25; issued by town and city clerks. License not required of resident or his immediate family to hunt or trap on agricultural lands on which actually domiciled; nonresident owning real estate valued at not less than $500, and nonresident member of club incorporated for hunting or fishing purposes prior to Jan. 1, 1909, which owns real estate assessed for taxation at value of not less than $1,000, may procure license at a fee of $1.25, licenses not issued to minors under 15 years of age. Written permission required to trap on inclosed lands of another.

Possession and sale: No restrictions on skins legally taken.

Shipment and export: No restrictions on skins legally taken.

Propagation: No legislation.

Bounties: Fox, $3; crow and certain hawks and owls, 25 cents; paid by State.

SOUTH CAROLINA.

Open seasons:	*Dates inclusive.*
Bear, mink, muskrat, otter, skunk	Oct. 1–Mar. 15.
Raccoon,[67] opossum	Sept. 1–Feb. 28.
Fox	Sept. 1–Feb. 15.[68]
Other fur animals	Unprotected.[69]

Prohibited methods: Hunting at night prohibited except for raccoon, opossum, or fox. Unlawful to shoot or trap foxes, to dig them out of the ground, or to push or drag them out of a tree or log.

Licenses: Hunting license required: Resident, county license, $1.10; State, $3.10; issued by county clerk or game warden; nonresident, $15.25; issued by county clerk. No license required of resident owners, tenants, their children, or, under written permission, their employees to hunt during open season on own lands. Consent of owner or manager required to hunt or trap on lands of another.

Possession and sale: No restrictions on skins legally taken.

Shipment and export: Shipments must be labeled to show the number and kind of animals in the package and the consignor and consignee. No other restrictions on skins legally taken.

Propagation: No legislation.

Bounties: None paid.

SOUTH DAKOTA.

Open seasons:	*Dates inclusive.*
Mink, muskrat, skunk (season opens at noon and closes at noon)	Dec. 1–Mar. 1.[70]
Beaver,[70] otter	No open season.
Other fur animals	Unprotected.

Prohibited methods: Unlawful to shoot muskrats, or to destroy or molest muskrat houses, except thes may be opened without injury thereto for the purpose of placing traps therein during open season. N person may set or operate more than 75 traps at any one time.

Licenses: Resident, $5; nonresident, $25; issued by game warden and county treasurer. License no required of residents under 14 years of age, nor of landowners trapping on own lands during open season Unlawful to hunt on cultivated or posted lands of another without permission of owner.

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[66] *Rhode Island:* Landowner may kill fur animals on own land at any time.

[67] *South Carolina:* Raccoons may be killed from July 15 by the owners of crops which they are destroying

[68] Foxes doing damage may be shot on one's own premises at any time.

[69] Wildcats may be killed without license at any time by officers of the law and landowners upon thei own holdings.

[70] *South Dakota:* Skunks doing damage around buildings may be killed at any time, and, under permi from State game warden, muskrat or beaver damaging irrigation ditches, embankments, or public highway may be taken at any time.

Possession and sale: Unlawful to possess, buy, or sell raw skins of protected fur animals during close season, whether taken or killed within or without State.

Shipment and export: Unlawful to ship raw skins of protected fur animals during close season, whether taken or killed within or without State.

Propagation: Not permitted.

Bounties: State pays $5 for each grown buffalo, black, or gray timber wolf; $2 for each pup thereof; mountain lion, $3; coyote or prairie wolf, $2; proportionate amount paid if the appropriation is not sufficient to pay full bounties. A county may pay $50 for each grown wolf, $4 for each wolf (other than coyote or prairie wolf) less than one year old, $10 for each mountain lion, and $4 each for coyote or prairie wolf, fox, lynx, and bobcat.

TENNESSEE.

Open seasons:[71]	*Dates inclusive.*
All fur animals (season opens at noon and closes at noon) (see exceptions)	Oct. 15–Jan. 15.[72]
Exceptions:	
Cannon, Chester, Dickson, Lewis, and Stewart Counties: All fur animals	Unprotected.
Blount, Carter, Greene, Johnson, Monroe, Sevier, Unicoi, and Washington Counties: Fox	No open season.[73]
Cocke, Meigs, and Rhea Counties: Foxes	No open season.[74]
Davidson, Robertson, and Shelby Counties: Beaver, muskrat, fox, mink, raccoon, skunk, opossum	Sept. 1–Jan. 31.[71]
Dyer County: Raccoon, mink, otter	Oct. 1–Feb. 15.[71]
Franklin County: Beaver, muskrat, fox, mink, raccoon, skunk, opossum	Nov. 1–Jan. 31.
Greene County: Fox	Nov. 1–Mar. 1.[75]
Muskrat	Dec. 15–Mar. 15.
Other fur animals	Dec. 15–Feb. 15.
Hawkins County: All fur animals	Nov. 15–Jan. 15.[74]
Smith County: All fur animals	Oct. 15–Feb. 15.[76]
Warren County: All fur animals	Nov. 1–Feb. 28.

Prohibited methods: Steel traps must be placed at least 12 inches within the entrance to a hole, cave, den, or hollow log.

Licenses: None required. Written consent required to trap on lands of another. Traps and deadfalls must be inspected within each 36 hours, and captured animals removed; does not apply to trapping wildcats in Lauderdale County.

Possession and sale: No restrictions, except locally. In Davidson, Franklin, Robertson, and Shelby Counties the sale of protected fur animals is prohibited from February 1 to October 31. In Meigs and Rhea Counties the sale of live foxes or pelts of foxes caught or killed in said counties is prohibited.

Shipment and export: No restrictions except locally. In Davidson, Franklin, Robertson, and Shelby Counties it is unlawful to remove any protected fur animal from county.

Propagation: No legislation.

Bounties: Wolf or panther, $2 certificate issued by county court, the amount to be applied on payment of taxes.

TEXAS.

Open seasons:	
All fur animals (see exception)	Unprotected.
Exception: In Caldwell County, mink, raccoon, fox	No open season.

Prohibited methods: No restrictions.

Licenses: None required. Consent of owner necessary to trap on posted land.

Possession and sale: No restrictions.

Shipment and export: No restrictions.

Propagation: Permit must be obtained from game, fish, and oyster commissioner to trap or transport wild animals for propagation.

Bounties: None paid.

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[71] *Tennessee:* Fur animals may be taken on one's own land at any time.

[72] In *Claiborne, Grainger, Davidson, Roane,* and *Shelby Counties* it is unlawful to set a trap more than 200 yards from trapper's residence.

[73] In *Blount, Carter, Greene, Johnson, Sevier, Unicoi,* and *Washington Counties* traps may be set near farm buildings and foxes may be killed when they destroy fowls or live stock.

[74] In *Cocke, Hawkins, Meigs,* and *Rhea Counties* foxes may be chased or killed with dogs or killed when injuring poultry or live stock.

[75] In *Greene County* fox destroying domestic fowl may be killed at any time.

[76] In *Smith County* fur animals may be killed at any time to protect property.

UTAH.

Open seasons:

Beaver, otter, marten	No open season.[77]
Other fur animals	Unprotected.

Prohibited methods: No restrictions.

Licenses: None required. Aliens other than homesteaders are not allowed to hunt or trap.

Possession and sale: Possession and sale of skins or any part of protected fur animals prohibited unless duly tagged by commissioner.

Shipment and export: Shipment and export prohibited, except commissioner may ship beaver killed under permit and tagged.

Propagation: No legislation.

Bounties: Wolf, $62.50; bear, mountain lion, cougar, $30; coyote, $4; lynx, bobcat, $3.

VERMONT.

Open seasons:[78]	*Dates inclusive.*
Mink, muskrat (see exception)	Mar. 15–Apr. 15.
Exception: On shores of Lake Champlain in Rutland County, Poultney River below Carvers Falls, and shores of Lake Memphramagog in Orleans County	Jan. 1–Apr. 30.
Otter, marten, raccoon, fisher, skunk	Oct. 25–Feb. 15.
Fox (by trapping)	Oct. 25–Feb. 15.[79]
Beaver	No open season.
Other fur animals	Unprotected.

Prohibited methods: The use of set guns is prohibited; bear traps must be carefully safeguarded and visited once in 48 hours. Unlawful to open or destroy a muskrat house or to place a trap at its entrance. Unlawful to dig skunks from dens or to drive them out by use of smoke or chemicals.

Licenses: Resident, 75 cents; nonresident, $10.50; issued by town clerk. Owners of farm lands and their resident minor children or tenants may take fur animals on own lands during open season without a license. License not issued to person under 16 years of age without written consent of parent or guardian. Nonresident owning improved real estate appraised at not less than $1,000, upon which he pays taxes, may obtain a resident license. Persons trapping on inclosed lands of another must, within 1 hours, inform owner of location and number of traps and must visit traps at least once in 24 hours.

Possession and sale: Possession of fur animals during close season prohibited, but the fur or skins of animals legally taken may be possessed, bought, or sold at any time.

Shipment and export: Packages containing fur animals or parts thereof delivered to a common carrier for transportation must be tagged to show the number and kind of such animals or skins therein, names of consignor and consignee, station from which shipped, and destination. A person required to have a license must also show the number of his license on the shipping tag. No other restrictions on skins legally taken and possessed.

Propagation: The State fish and game commissioner issues special permits for propagating fur and game animals (fee, $2 and expense of tagging). Animals bred on fur farms may be sold and transported alive at all times when bearing the identification tags prescribed by the commissioner.

Bounties: Black bear taken between May 1 and November 1, $10; hedgehog (porcupine), 35 cents; paid by State. Towns pay $8 bounty on bay lynx or bobcat.

VIRGINIA.

Open seasons:	*Dates inclusive.*
All fur animals (season opens at noon and closes at noon) (see local laws)	Oct. 15–Jan. 15.[80]
Jefferson magisterial district—in Culpeper County: Fox (trap)	Nov. 1–Dec. 31.[81]
Fauquier and Loudoun Counties: Fox	Sept. 1–Mar. 31.[82]
Halifax County: Opossum	Oct. 15–Jan. 31.
King George County: Muskrat	Dec. 20–Mar. 31.

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[77] *Utah:* When beaver are destroying property, the State fish and game commissioner may grant permits to kill them, but the hides of animals so taken must be delivered to and sold by commissioner who may recompense for trapping in not more than one-half of the proceeds from sales.

[78] *Vermont:* Fur animals may be killed at any time to protect one's own property.

[79] Fox may be taken otherwise than by trapping at any time.

[80] *Virginia:* Law applies to any county after adoption by the board of supervisors. Trapping on lands of another is unlawful except from noon of Oct. 15 to noon of Jan. 15, and then is lawful only with written permission of landowner, which permission the trapper must have on his person when trapping. He must visit traps at least once every 36 hours and is liable for any damage such traps may do to domestic animals. Landowner may trap or kill fur animals on his own lands at any time.

[81] Traps must be visited daily in Jefferson magisterial district, Culpeper County.

[82] Fox may be taken at any time by owner or tenant of land to protect property in Fauquier and Loudoun Counties. Written permission of owner required to take foxes on lands of another.

Open seasons Continued.

Loudoun County: Mink, muskrat, skunk	Nov. 1–Feb. 28.
Opossum, raccoon	Oct. 1–Feb. 28.
Nansemond County: Mink, otter, muskrat	Jan. 1–Mar. 31.
Patrick County: Raccoon, opossum	Oct. 15–Mar. 14.
Gray fox	Sept. 15–Mar. 14.
Princess Anne County: Mink, muskrat, otter (for profit)	Nov. 1–Mar. 14.

Prohibited methods: Unlawful to shoot muskrats at night with aid of lights in tidewater sections of State.

Licenses: Hunting license required to trap: Nonresident, $10; alien, $20 (alien owner of real estate resident for five years, same as resident). Resident: State, $3; county of residence, $1. Issued by clerks of circuit and corporation courts.

Nonresident may hunt on own land during open season without a license. Owner, members of family, and tenant of land residing thereon may hunt without license during open season on own or adjoining lands with consent of owner. Local provisions: In Loudoun County (fee $2.50), to trap on lands of another; in Loudoun and Rappahannock Counties, written permission is required to trap or hunt on lands of another.

Possession and sale: No restrictions except in Patrick County, where the sale of protected fur animals during close season is prohibited.

Shipment and export: No restrictions.

Propagation: License required (fee, $25) to raise game or fur animals.

Bounties: None paid.

WASHINGTON.

Open seasons:	*Dates inclusive.*
Bear	Sept. 1–May 1.[83]
Beaver	No open season.
Other fur animals	Unprotected.

Prohibited methods: No steel trap larger than No. 4 may be used unless a notice in the English language on a large placard is placed above the trap.

Licenses: County, $5; issued by county auditor. Not required to trap coyote, muskrat, mink, skunk, marten, civet cat, weasel.

Possession and sale: Carcass and pelt of bear lawfully taken may be sold at any time; beaver skins secured without the State, after being inspected and stamped by the game warden, may be possessed or sold at any time.

Shipment and export: Carcass and pelt of bear and skins of other fur animals legally taken and possessed may be shipped at any time.

Propagation: Breeder's license (fee, $10; renewal, $5) required.

Bounties: Mountain lion or cougar, $20; lynx or wildcat, $5; coyote, $1; timber wolf, $15; seal or sea lion in Columbia River district, $1; paid by State. Counties are permitted to pay additional rewards for destroying these animals, and also bounties on bear, muskrat, and squirrel.

WEST VIRGINIA.

Open seasons:[84]	*Dates inclusive.*
Skunk	Dec. 1–Feb. 1.
Red fox, in Brooke, Cabell, Doddridge, Harrison, Kanawha, Mason, Mingo, Morgan, Pleasants, Roane, Summers, Taylor, Upshur, Wetzel, Wirt, and Wyoming Counties only	Dec. 1–Feb. 1.
In rest of State	Unprotected.
Raccoon, mink, and other fur animals	Unprotected.

Prohibited methods: Unlawful to set a steel or spring bear trap on land of another.

Licenses: Hunting license required to trap skunks: Resident, $1; nonresident, $15; issued by county clerk. Resident landowner, his resident children or tenants, may hunt during open season on own land without a license. License not required of minor under 15 years of age. Express permission of owner or tenant required to set or maintain a snare or trap upon land of another. Licensee must wear tag.

Possession and sale: No restrictions on skins legally taken.

Shipment and export: No restrictions on skins legally taken.

Propagation: No restriction on possession or sale, but animals must not be taken for breeding purposes in close season except on lands owned or tenanted by the breeder.

Bounties: Wildcat, bobcat, or catamount, $5; crow, 10 cents; certain hawks and owls, 25 cents; paid from forest, game, and fish protection fund.

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[83] *Washington:* Bear may be killed at any time when destroying domestic animals.

[84] *West Virginia:* A landowner, his agent, or tenant may hunt or kill fur animals on his own lands at any ime.

WISCONSIN.

Open seasons:	*Dates inclusive.*
Beaver, otter (see exceptions), marten, fisher	No open season.[85]
Exceptions: Beaver, otter, in Ashland, Bayfield, Chippewa, Clark, Douglas, Iron, Oneida, Price, Rusk, Sawyer, Taylor, and Washburn Counties only (under special license)	Feb. 1–Mar. 31.
Mink	Nov. 1–Mar. 31.
Raccoon, skunk	Oct. 15–Jan. 31.
Muskrat[85] (see exceptions)	Nov. 1–Mar. 31.
Exceptions: In Calumet, Dodge, Manitowoc, and Sheboygan Counties	Feb. 1–Mar. 31.
In Waupaca, Waushara, and Winnebago Counties	Oct. 25–Mar. 31.
Black bear	Unprotected.

Prohibited methods: Unlawful to take beaver, otter, mink, or muskrat with the aid of spear, gun, or dog; to disturb or molest muskrat houses, beaver houses, or beaver dams; to set traps within 500 feet of any beaver dam or beaver house; or to molest or disturb raccoon den trees for the purpose of capturing raccoons.

Bag limits: Five raccoons a day.

Licenses: Resident, $2.50 (25 cents to boy under 16); issued by conservation commission. Report required from licensed trapper on or before June 1 of each year. Nonresident not permitted to trap; alien not permitted to hunt. Beaver and otter license, fee, $5; skins must be tagged with metal tag, fee 50 cents. Written consent of owner or occupant required to trap beaver, otter, mink, or muskrat on agricultural lands of another.

Possession and sale: Possession and sale of beaver or skins thereof prohibited except when properly tagged; possession of green skins of fur animals permitted only during open season and first five days of close season; possession prohibited of the skin of fisher, marten, mink, or muskrat which shows that the animal has been shot or speared. No other restrictions on possession and sale of skins legally taken.

Shipment and export: Shipment and export of beaver prohibited except when properly tagged; shipment of hides must be marked to show the number and kinds of hides, the name and address of the shipper and the number of his trapping license.

Propagation: Under permit and supervision of the commission wild animals may be taken and transported for propagation within the State. Special license required for muskrat farming (fee, $5, and 1 cent per acre for all premises in excess of 500 acres covered by the license).

Bounties: Wolf cub taken between March 1 and November 1, $4; mature wolf killed at any time, $10; fox, $2; paid by county. County boards may increase these rewards, but no county may pay more than $6 for killing a wolf cub. The State treasurer duplicates all county awards, thus doubling the above bounties. Poisons may be used for destroying animals for bounty between December 1 and March 1, but notice of putting out baits must be posted, and they may not be placed within 80 rods of a dwelling house. County boards may offer bounty on crow, hen hawk, pocket gopher, streaked gopher, English sparrow blackbird, or rattlesnake.

WYOMING.

Open seasons:	
Beaver	No open season.[8
All other fur animals	Unprotected.

Prohibited methods: Unlawful to trap bears.

Licenses: For trapping in State game preserves, fee, $5, for trapping in national forests, $5; issued b State game warden. Employees of the Federal Government do not require permit to trap predator animals. For bear: Resident (hunting license), $2.50; nonresident, $25; limit, 3 bears; issued by commissioner. Nonresident may take 3 bears Sept. 15–Nov. 15 under big game license. The killing o a bear must be reported not later than December to the commissioner. Dog license, $1 (required fo each dog used in hunting predatory animals in national forests).

Possession and sale: Skins of beaver killed when doing damage to real estate may be possessed when dul tagged by commissioner and affidavit is furnished the commissioner by owner of the real estate showin the damage and number of beaver killed, and upon the payment of 50 cents for each beaver hide.

Shipment and export: Beaver hides must be tagged by commissioner before being shipped or transporte

Miscellaneous: Use of the flesh of game animals or birds as trap bait for predatory animals prohibited.

Propagation: Beaver may be taken for propagation under a $5 permit, but animals so taken must be kep 3 years before being killed or sold.

Bounties: None paid by State.

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[85] *Wisconsin:* If beaver damage property, they may be captured and removed under permit and th direction of the State conservation commission; skins of animals that are killed in taking must be delivere to the conservation commission. Owners or lessees of dams, under permit of conservation commissio may destroy at any time muskrats to protect such dams or levees, but they may not sell, barter, or gi away the skins of such animals killed during close season.

[86] *Wyoming:* Close season on beaver expires Mar. 15, 1925. If beaver damage real estate the own thereof may destroy them, but must furnish State game and fish commissioner with affidavit showi damage and number killed.

LAWS OF CANADA.

ALBERTA.

Open seasons:	*Dates inclusive.*
Mink, fisher, marten	Nov. 1-Mar. 31.[89]
Otter	Nov. 1-Apr. 30.
Muskrat (*see exception*)	Dec. 1-Apr. 30.
Exception: Muskrat, south of North Saskatchewan River	No open season.[90]
Beaver	Dec. 31, 1925.[90]
Fox and other fur animals	Unprotected.[91]

Prohibited methods: Unlawful to use poison for taking fur animals; or to destroy, partially destroy, or to leave open any muskrat or beaver house.

Licenses: *Trapping:* None required of residents; nonresident, $25; issued by minister of agriculture. Consent of owner or occupant required to trap on inclosed or cultivated lands of another. Permits to trap on game or forest reserves may be granted under regulations of the Lieutenant Governor in Council. *Taxidermist*, $5. *Dealer* in furs and skins of protected animals: Resident, branch office, and traveling agent, $5 each; nonresident, $100. Licensee must make monthly and annual reports to department of agriculture. License to export skins, $1; issued by minister.

Possession and sale: No restrictions on skins legally taken and possessed.

Shipment and export: Export of furs and skins prohibited except by holder of a license. No furs or skins on which royalty has not been paid may be exported, and a special permit from the minister is necessary to ship out unprime skins. Resident hunter or trapper exporting furs or skins of animals taken by himself is not required to pay royalties on skins so exported unless the tax exceeds the sum of $10 in any one year. Export of live fox prohibited.

Propagation: Manager of fur farm required to make reports January 1 and July 1 of each year. Export of live animals from fur farms allowed only on permit from the Minister of Agriculture. Permit, with fees, required to export live muskrat, mink, fisher, marten, otter, or beaver, whether raised on a fur farm or otherwise (orders in council).

Bounties: The council of any rural municipality is authorized to offer a bounty on wolf.

BRITISH COLUMBIA.

Open seasons: [92]	*Dates inclusive.*
Bear (see exception)	Sept. 1-June 30.
Exception: On Vancouver Island (1921)	Nov. 1-June 30.

Prohibited methods: Unlawful to use poison in taking fur animals, except that farmers and poultrymen may protect own stock. Unlawful to trap bear.

Bag limits: Two grizzlies and 3 bears of any other species a season.

Licenses: *Trapping:* Resident, $10; nonresident not permitted to trap; nonresident (special license to hunt—not trap—bear from January 1 to July 1), $25; nonresident general hunting license, fee, $25 and additional fees of $15 to $25 for each bear killed. License not issued to boys under 18 years of age without written consent of parent or guardian. Issued by Provincial game warden or authorized agent. Licensee must wear badge. No license required of a resident to trap on own land during open season. Permission of owner required to trap on inclosed, cleared, or cultivated land of another. A licensed trapper who first occupies a trap line prior to November 14 is protected against other trappers. Unlawful to touch or interfere with traps set by a licensed trapper. License must be returned within two months after it expires, with a statement of number of fur animals of each kind taken. *Fur dealer:* Resident, $25 (does not apply to licensed trapper selling skins taken by himself); nonresident or his agent, $200, License required for each place of business. Fur dealer must make verified report on or before August 31 showing number and kinds of skins purchased and date of transactions. *Taxidermist*: $5. Game conservation board may grant permits (fee, $25) to buy furs at wholesale from licensed fur dealers or at public auction.

Possession and sale: Unlawful to sell pelts taken during close season. Possession of pelts of fur animals allowed only during open season and for two months thereafter (three months, north of 52d parallel), except under special permit from Provincial game warden. Unlawful for fur trader to possess skins on which royalty has not been paid. Does not apply to skins taken by a licensed trapper if sold to a licensed resident dealer nor to skins of animals raised in captivity. Bears may be sold during open season.

hipment and export: Export of pelts of fur animals allowed only during open season and for two months thereafter (three months, north of 52d parallel), under special permit of Provincial game warden. Packages must be prepared so that they may be easily opened for examination, or labeled with a full description of the contents, and names and addresses of the consignor and consignee.

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[89] *Alberta:* Unlawful to destroy a beaver dam, unless authorized to do so by the Lieutenant Governor in ouncil, who may also authorize the killing of beaver or other fur animals when such killing is deemed to e in the public interest.

[90] Lieutenant Governor in Council may declare open seasons locally on beaver and muskrat.

[91] Unlawful to trap fox for export.

[92] *British Columbia:* Seasons on fur animals fixed annually by Lieutenant Governor in Council. For gulations, apply to Secretary, Game Conservation Board, Vancouver, British Columbia.

Propagation: A permit from the game conservation board is required to propagate fur-bearing animals. Breeder must keep a record of transactions as to purchases and sale of stock, which record must be open to inspection of any game warden, and must make verified report to game conservation board on o before August 31. Live foxes may be exported only under permit, and a permit is required to take foxes or other fur animals in close season.

Bounties: Panther, $40; timber wolf, $25; coyote, $2 (if not less than one week old); big-horned or snowy owl, $1; magpie and crow, 20 cents each; eagle, $1. (Rates fixed from time to time by Lieutenant Governo in Council.)

MANITOBA.

Open seasons: [93]

North of fifty-third parallel—	*Dates inclusive.*
Fisher, pekan, sable, marten, mink	Nov. 1–Mar. 31.
Otter, beaver	Nov. 1–Apr. 30.
Muskrat (additional season, Nov. 1–30)	Mar. 15–May 15.
Fox, lynx	Nov. 1–Feb. 28.
South of fifty-third parallel—	
Fisher, pekan, sable, marten, mink	Nov. 1–Mar. 31.
Beaver,[94] otter	No open season.
Muskrat	Mar. 15–Apr. 30.
Fox, lynx	Unprotected.

Prohibited methods: Use of poison in taking fur animals is prohibited. Unlawful to shoot or spear muskrats or to destroy muskrat houses.

Licenses: *Trapping:* Resident, $2; nonresident Canadian citizen, $25; nonresident alien, $100; issued b Minister of Agriculture and Immigration. Permission of owner required to trap on cultivated or inclose lands of another. Licensee must return his license and make a report during the month of June showin the number of each kind of animal taken. *Fur trading:* Wholesale raw fur dealer, $50; raw fur buye $25; resident raw fur merchant or trader, $10; resident traveling agent, $10; issued by Minister. Licensee are required to keep record and to make annual returns before September 30. *Fur dressing and tannin* $10; issued by Minister. Licensee must keep records and report to the chief game guardian on or befo the 10th of each month the number of royalty pelts handled and the name and address of person forwar ing or delivering the skins.

Possession and sale: Possession of unprime skins prohibited. Unlawful to purchase or sell the skins muskrats that have been speared or shot. Any person purchasing or acquiring pelts from a trapper mu ascertain that he holds proper trapping permit and at the same time record his name and the number his permit. Unlawful to purchase, barter, or trade the pelt of a fur animal taken during close seaso (does not apply to imported skins). No other restrictions on skins legally taken.

Shipment and export: Export prohibited of unprime skins or skins on which royalty is payable unless suc skins have coupons attached to show royalty paid; each shipment must have attached a declaration the number and kinds of skins contained, and also set forth that royalty coupons are attached as r quired. No other restrictions on skins legally taken. Export prohibited of live protected anima (except ranch-bred animals) except under permit from Minister of Agriculture and Immigration (pe mit must accompany shipment to destination); fees, for black or silver fox; $100; for other fox, $15; f otter, $25; for beaver, $5; for mink, fisher, or marten, $1; for muskrats, $2 a dozen or fraction thereof.

Propagation: License (fee, $5) must be obtained from the Minister to operate a fur farm. Licensee, on before the first days of January and July, must make verified reports showing the number, species, a and sex of the animals on hand, from whom procured, and the number which have died during previo six months, with cause of death.

Bounties: Timber wolf,[95] $5; other wolf,[95] $2; half is refunded to municipality by Provincial treasurer.

NEW BRUNSWICK.

Open seasons:

	Dates inclusiv
Mink, otter, fisher, martin, sable	Nov. 1–Mar. 31
Fox	Oct. 1–Mar. 1.
Muskrat (see exception)	Mar. 25–May 1.
Exception: In Carleton, Gloucester, Kent, Madawaska, Northumberland, Restigouche, and Victoria Counties	Mar. 25–May 2
Beaver	No open season
Other fur animals	Unprotected.

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[93] *Manitoba:* Trapping in Provincial game preserves prohibited.

[94] Chief game guardian may take necessary steps to prevent beaver doing damage, but no beaver da may be disturbed between Oct. 1 and Apr. 1.

[95] Poison may not be used to capture wolves for bounty.

[96] *New Brunswick:* Expires Nov. 1, 1924. Holder of permit from Minister may take beaver at designat times.

Prohibited methods: Unlawful to take fur animals by use of poisons, with aid of hounds, or with gun equipped with silencer; to dig out foxes from their homes or earth burrows; or to shoot muskrats.

Licenses: *Trappers and fur dealers:*[97] Persons domiciled in Province, $10; all other persons, $50. Trappers and fur dealers must furnish the Minister with written declarations showing their names and addresses, the location of warehouses, shops, posts, or caches where skins are to be stored, and the places from which the skins will be shipped out of the Province, and must make monthly reports of operations. Issued by Minister of Lands and Mines. License is required to traffic in, cure, or tan skins: Resident, $10; nonresident or resident alien, $50; issued by Minister. Special license (accompanied by necessary tags) to trap beaver at designated times may be issued by Minister: fee, $5 for each animal.

Possession and sale: Possession prohibited of furs on which royalties, as fixed by Lieutenant Governor in Council, have not been paid; possession of green skins or carcasses of protected fur animals in close season prohibited.

Shipment and export: Skins legally taken, possessed, tagged, and on which the royalty has been paid, may be exported under permit from Minister. Permit from Minister required for live fur animals.

Propagation: Permits to capture wild fur-bearing animals for propagation within the Province may be obtained from the Minister, who fixes the fee for such permit.

Bounties: None paid.

NORTHWEST TERRITORIES.[98]

Open seasons:[99]	*Dates inclusive.*
Mink, fisher, marten	Nov. 1–Mar. 14.
Otter, beaver, muskrat[100]	Oct. 1–May 14.
Foxes	Nov. 15–Mar. 31.

Prohibited methods: Unlawful to use poison in taking fur animals or to destroy or injure any beaver or muskrat house.

Licenses: *Trapping:* Resident, $2; nonresident, British subject, $25; other nonresident, $50. *Fur dealer,* $5; issued by Commissioner of Dominion Parks. License not required of native-born resident Indian, Eskimo, or half-breed.

Possession and sale: Licensed trapper may sell or trade the skins of animals he has legally taken. Possession of unprime or low-grade furs prohibited. No restrictions on other skins legally taken.

Shipment and export: No restrictions on skins legally taken and possessed.

Propagation: Permits may be obtained to take fur animals for propagation.

Bounties: Timber wolf, $20.

NOVA SCOTIA.

Open seasons:[1]	*Dates inclusive.*
Beaver, marten, fisher	No open season.
Bear, wolf, wildcat	Unprotected.
Other fur animals	Nov. 15–Jan. 15.

Prohibited methods: Unlawful to take any protected fur animal (unless under a permit) from a burrow or den by smoking, digging, or otherwise; to take fur animal by use of poison; to damage or molest a beaver dam or house or a muskrat house or to set snare or trap within 25 feet of the latter.

icenses: *Trapping:* None required of resident; nonresident, $30; issued by Provincial secretary, game commissioners, and county clerks. *Fur buyers:* Nonresident, $25; resident, $2, issued by chief game commissioner. Fur buyer must keep record and make monthly report of number of skins bought or sold, together with names and addresses of parties from whom purchased or to whom sold.

ossession and sale: Unlawful to possess or sell the green hide of any beaver, fisher, or marten, or to possess the green hide of any fur animal taken out of season. No other restrictions on skins legally taken.

hipment and export: Unlawful to export skins of fur animals except under certificate of inspection and permit (fee, 50 cents) from a game official (postmaster).

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[97] *New Brunswick;* License requirements and other provisions of act do not apply to a hunter or trapper ho is a British subject domiciled and residing in Province, who actually hunts, provided he sells his rs to a person domiciled in the Province.

[98] "*Northwest Territories*" means the northwest territories formerly known as Rupert's Land and the orthwestern Territory (except such portions thereof as are included in the Provinces of Ontario, Quebec, anitoba, Saskatchewan, and Alberta, and the Yukon Territory), together with all British territories d possessions in North America and all islands adjacent thereto not included within any Province, except e Colony of Newfoundland and its dependencies.

[99] All trapping prohibited on Victoria and Banks Islands.

[100] North of latitude 64° the open season on muskrats extends to June 14.

[1] *Nova Scotia:* Fox, raccoon, skunk, weasel, or muskrat may be killed on one's own inclosed premises for e protection of private property.

Propagation: Permits (fee, $1) to take wild animals may be obtained from the board of game commissioners under such restrictions as they may require. Unlawful to keep fur-bearing animals in captivity for breeding purposes without a permit from the chief game commissioner; fee, $2 for each kind of animal kept, payable annually. Reports are required annually on September 30. Unlawful to trespass in inclosures for fur animals.

Bounties: None paid.

ONTARIO.

Open seasons:	*Dates inclusive.*
Mink, fisher, marten, raccoon	Nov. 1–Apr. 15.
Muskrat (see exception)	Apr. 1–May 21.
Exception: South of French and Mattawa Rivers	Mar. 1–Apr. 21.
Beaver, otter	Dec. 1–Mar. 31.[2]
Other fur animals	Unprotected.

Prohibited methods: Unlawful to shoot or spear muskrats or, except when they are destroying property, to injure their houses.

Licenses: Resident: General, $15; limited (does not authorize taking beaver or otter), $5; nonresident, $50; issued by Department of Game and Fisheries. Nonresident not permitted to take beaver or otter. Beaver and otter skins must bear prescribed coupons (trapper limited to 10 coupons for beaver and otter a season). Farmers and their sons may trap on own land during open season without license, except that a $1 license is necessary to trap beaver or otter thereon. Permission of owner required to trap beaver on lands of another. Treaty Indian living north and west of French and Mattawa Rivers and Lake Nipissing and holding annual certificate from Department of game and fisheries not required to obtain trapping license, but is limited to 10 beaver or otter a season, the skins of which may only be sold to persons licensed to issue coupons. Treaty Indian must produce his certificate to buyer and have indorsed thereon the number of the coupon attached thereto. Fur dealers or traders: Resident British subject, $25 (store license), $100 (traveling fur buyer), $100 (wholesale license); alien or nonresident, $200; nonresident, $5 (buying from wholesalers); licensee must make monthly reports. Fur dressing and tanning, $10; licensee must keep records and make monthly reports.

Possession and sale: Possession of furs during close season prohibited except under permit. Possession and sale of unprime skins prohibited, except under permit. Unlawful for trapper or farmer to sell beaver or otter skins except to a licensed dealer. Unlawful to have skins dressed, plucked, or treated in any way except under permit obtained upon payment of royalties.

Shipment and export: Export prohibited except under permit obtained upon payment of royalties. No other restrictions on skins legally taken, possessed, or tagged. Shipments must be made by express or parcel post and packages must be marked with a list of the contents and the names and addresses of consignor and consignee.

Propagation: A permit is required of breeders of game or fur animals. Licensed fur breeders may sell live animals or skins during open season upon payment of royalties. The Minister may grant permits to take fur animals during the close season for propagating and scientific purposes.

Bounties: Gray timber wolf, $20; other wolf, $5; paid by county, but Provincial treasurer refunds 40 per cent to county. Provincial treasurer pays entire bounty in unorganized counties.

PRINCE EDWARD ISLAND.

Open seasons:	*Dates inclusive.*
Otter, marten, mink, muskrat	Nov. 1–Mar. 31.
Beaver	No open season.[3]
Other fur animals	Unprotected.

Prohibited methods: Unlawful to put out poisoned baits for fox or other animals.

Licenses: None required of resident; nonresident, $50; issued by secretary-treasurer of Province. The game warden may grant permits to take beaver and issue coupons (fee, $1 each) to tag skins of animals taken.

Possession and sale: Possession and sale during close season prohibited. Holders of permits may possess, buy, or sell beaver skins which have proper coupons attached.

Shipment and export: No restrictions on animals legally taken, possessed, and tagged.

Propagation: Several special acts of the Provincial legislature regulate fox ranching on the island. The animals are assessed for taxation, ranches are protected from trespass under heavy penalties, and incomes from ranches are taxed.

Bounties: None paid.

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[2] *Ontario:* Beaver and otter may be taken by residents only. Not more than four beavers may be taken from a family or colony. Beavers, when damaging property, may be destroyed by game overseer under special authorization from the department of game and fisheries.

[3] *Prince Edward Island:* Beaver may be taken under special license. They may be destroyed by the owner of private property on which they are locating or building dams, and, under permit from game warden or Lieutenant Governor in Council, their dams may be destroyed when necessary to prevent damage to property.

QUEBEC.

Open seasons:	*Dates inclusive.*
Bear	Aug. 20–June 30.
Muskrat (see exception)	Nov. 1–May 31.
Exception: South of 50th parallel	Mar. 15– Apr. 30.
Fox	Nov. 1–Feb. 28.
Other fur animals	Nov. 1–Mar. 31.

Prohibited methods: Use of poisons in taking fur animals prohibited.

Licenses: Fur dealers: Persons domiciled in Province, $25; all other persons, $100; issued by Minister of Fisheries and Game. Fur dealers must furnish the Minister with written declarations showing their names and addresses, location of warehouses, shops, posts, or caches where skins are to be stored, and the places from which such furs will be shipped out of the Province. This act does not apply to a hunter or trapper who actually hunts, if he is domiciled and resides in the Province, and is a British subject.

Possession and sale: Persons engaged in buying, selling, or taking fur animals must, on or before the 10th of each month, make report to the Minister. Unlawful to possess, buy, or sell skins of fur animals on which royalty has not been paid. No other restrictions on skins legally taken.

Shipment and export: Shipment and export prohibited, except of fur animals or furs on which royalties have been paid. Skins must be shipped open to view and each skin must be stamped to show royalty paid and be tagged as prescribed by the Minister before being shipped in any manner. Packages must show names and addresses of consignor and consignee.

Propagation: The Minister may grant permits to take animals alive for breeding purposes; nonresident license fee, from $5 to $25.

Bounties: Wolf, $15.

SASKATCHEWAN.

Open seasons:[5]	*Dates inclusive.*
Beaver	Dec. 1–Apr. 30.[6]
Mink, fisher, marten, fox (see exception)	Nov. 1–Mar. 31.
Exception: Fox, south of Township 51	Unprotected.
Otter	Nov. 1–Apr. 30.
Muskrat:[7]	
North of Township 52 (also Nov. 1 to Nov. 30)	Mar. 1–May 14.
South of Township 53	Mar. 1–Apr. 30.
Other fur animals	Unprotected.

Prohibited methods: Unlawful to use poison to take fur animals, to spear or shoot beaver or muskrat, or to destroy muskrat houses.

icenses: Resident, $2; nonresident, $25; resident licensee must return license on or before May 31 to chief game guardian with statement showing number of each kind of fur animals taken by him. Fur dealer, resident, north of Township 25, $10; south of Township 26, $2; traveling agent for resident dealer, $10; nonresident or his traveling agent, $20; taxidermist, $5; licensee must keep duplicate receipt book and furnish a copy thereof every 3 months to the Minister. Issued by Department of Agriculture, Regina. Licensed fur trader must make annual report of operations. Resident treaty Indians may trap during open season without a license. Consent of owner or occupant required to trap on inclosed or cultivated lands of another. No license issued to person under 16 years of age without written consent of parent or guardian.

ossession and sale: Unlawful to buy, sell, or possess unprime furs, except those of wolf or coyote. No other restrictions on skins legally taken.

hipment and export: Packages containing fur animals must be plainly marked with full description of contents and names and addresses of consignor and consignee. Export of live fur animals prohibited except under permit of minister; fees, for black or silver fox, $25; for cross or red fox or other live fur animal, $5. Unlawful to ship unprime furs except wolf or coyote. No other restrictions on skins legally taken.

ropagation: Permit required (fee, $1 annually) to operate a fur ranch. Permit to ship live fur animals is required; fee, for black or silver fox, $25; for cross or red fox or other fur animal, $5. Young foxes may not be taken from dens before May 15.

ounties: Adult timber wolf, $10; pups of prairie or timber wolf, $1; paid only in properly gazetted wolf districts, when half is refunded from provincial treasury.

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[5] *Saskatchewan:* Trapping on game preserves prohibited.

[6] Beavers are protected on game preserves and may be protected in any municipality upon recommenda- on of the council and proclamation of Minister.

[7] Minister may authorize the council of any municipality to destroy muskrats doing damage to highways other public improvements.

YUKON.

Open seasons:[8]	Dates inclusive.
Lynx, marten, mink, otter	Nov. 15–Apr. 1.
Muskrat (see exception)	Dec. 1–June 1.
Exception: North of Arctic Circle	Dec. 1.–June 1
Beaver	No open season
Other fur animals (see exception)	Unprotected.
Exception: Fox (under 1 year of age)	June 1–Mar. 31.

Prohibited methods: Use of poison or pitfalls prohibited.

Licenses: [9]None required of resident; nonresident, $200. Fur buyer or dealer (purchasing furs for sa or export): Nonresident, $150; resident, $25; mercantile establishment buying furs, $25 (required f each place of business other than head office); issued by gold commissioner or person designated b him. (License not required of resident or mercantile establishment until Jan. 1, 1922.)

Possession and sale: Skins legally taken may be possessed and sold at any time.

Shipment and export: Export of raw furs prohibited except under permit issued by direction of the con missioner, and upon payment of the export tax. Export of live fox prohibited. (*See* Propagation

Propagation: Registration of fox breeders required. Unlawful to export a fox not born in captivity which has been in captivity for less than a year; any fox born in captivity may be exported under permit (fee, $5). Fox and other fur ranches, if posted against trespass, may not be approached withou owner's consent. No restrictions on other fur animals.

Bounties: None paid.

LAWS OF NEWFOUNDLAND.

Open seasons:[10]	Dates inclusive
Otter, marten, lynx	Oct. 1–Mar. 31.
Fox	Oct. 15–Mar. 15
Muskrat	Oct. 1–Apr. 30.
Beaver	No open season

Prohibited methods: Beaver house or dam must not be damaged by trapper.

Bag limits: Twenty-five beaver in such localities as are opened by Governor to trapping.

Licenses: None required of resident except for beaver (beaver trapping license issued only to reside trappers of 3 years' standing); nonresident, $50[11]; issued by justice. Fur buyers and shippers, 50 cent issued by game and inland fisheries board. Fur buyer must report operations semiannually on or befo June 30 and December 31 of each year.

Possession and sale: No restrictions on skins legally taken, except beaver.

Shipment and export: (See Licenses.) Unlawful to export live fox unless raised in captivity. No oth restrictions on skins legally taken, except beaver.

Propagation: No restrictions, except as to fox. A fox farm must be licensed; the owner must at stat times make reports to the game and inland fisheries board, and the premises must be at all times op to inspection by officers of the board. Possession of fox cub or fox taken in close season is prohibite Unlawful to export a fox not bred on a fox farm, or, without permit from the colonial board, to export fox bred in captivity.

Bounties: Crow 20 cents.

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[8] *Yukon:* Commissioner in council may alter seasons.

[9] Expires Nov. 1, 1923.

[10] *Newfoundland:* Unlawful to trap on Grand Lake Caribou Preserves.

[11] Governor in Council may proclaim open season on beaver in certain localities. Skins of beaver mu be forwarded through magistrate to Department of Marine and Fisheries which has sole power to purcha or export.

OFFICIALS FROM WHOM COPIES OF LAWS RELATING TO FUR-BEARING ANIMALS MAY BE OBTAINED.

Alabama: Department of Conservation, Montgomery.
Alaska: Secretary of Agriculture, Washington, D. C. See footnote 5, p. 6.
Arizona: State Game Warden, Phoenix.
Arkansas: Secretary, Game and Fish Commission, Little Rock.
California: Executive Officer, Fish and Game Commission, Postal Telegraph Building, San Francisco.
Colorado: State Game and Fish Commissioner, Denver.
Connecticut: Secretary, Commission of Fisheries and Game, Hartford.
Delaware: Chief Game Warden, Dover.
District of Columbia: Superintendent Metropolitan Police, Washington.
Florida: Secretary of State, Tallahassee.
Georgia: Game and Fish Commissioner, Atlanta.
Idaho: Fish and Game Warden, Boise.
Illinois: Chief Game and Fish Warden, Springfield.
Indiana: Superintendent, Division of Fisheries and Game, State House, Indianapolis.
Iowa: State Fish and Game Warden, Lansing.
Kansas: State Fish and Game Warden, Pratt.
Kentucky: Executive Agent, Game and Fish Commission, Frankfort.
Louisiana: Commissioner of Conservation, Court Building, New Orleans.
Maine: Commissioner of Inland Fisheries and Game, Augusta.
Maryland: State Game Warden, 512 Munsey Building, Baltimore.
Massachusetts: Director, Division of Fisheries and Game, State House, Boston.
Michigan: Director, Department of Conservation, Lansing.
Minnesota: Game and Fish Commissioner, St. Paul.
Mississippi: Secretary of State, Jackson.
Missouri: Game and Fish Commissioner, Jefferson City.
Montana: State Fish and Game Warden, Helena.
Nebraska: Chief Fish and Game Warden, Lincoln.
Nevada: Secretary of State, Carson City; and County Commissioners.
New Hampshire: Fish and Game Commissioner, Sunapee.
New Jersey: Secretary, Board of Fish and Game Commissioners, Trenton.
New Mexico: Game and Fish Warden, Santa Fe.
New York: Secretary, Conservation Commission, Albany.
North Carolina: Secretary, Audubon Society of North Carolina, Raleigh.
North Dakota: Secretary, Game and Fish Board, Steele.
Ohio: Chief Game Warden, Board of Agriculture, Columbus.
Oklahoma: State Game Warden, Oklahoma City.
Oregon: State Game Warden, Portland.
Pennsylvania: Secretary, Board of Game Commissioners, Harrisburg.
Rhode Island: Chairman, Commissioners of Birds, Providence.
South Carolina: Chief Game Warden, Columbia.
South Dakota: State Game Warden, Pierre.
Tennessee: State Game and Fish Warden, Nashville.
Texas: Game, Fish and Oyster Commissioner, Austin.
Utah: Fish and Game Commissioner, Salt Lake City.
Vermont: Fish and Game Commissioner, Montpelier.
Virginia: Commissioner of Game and Inland Fisheries, Richmond.
Washington: Director of Fisheries and Game, Olympia.
West Virginia: Game and Fish Commission, Charleston.
Wisconsin: Secretary, Conservation Commission, Madison.
Wyoming: State Game and Fish Commissioner, Cheyenne.

Alberta: Chief Game Guardian, Edmonton.
British Columbia: Secretary, Game Conservation Board, Vancouver.
Manitoba: Chief Game Guardian, Winnipeg.
New Brunswick: Chief Game and Fire Warden, Fredericton.
Northwest Territories: Commissioner, Canadian National Parks, Ottawa.
Nova Scotia: Chief Game Commissioner, Halifax.
Ontario: Superintendent, Game and Fisheries, Toronto.
Prince Edward Island: Game Inspectors (county sheriffs).
Quebec: General Inspector, Fisheries and Game, Quebec.
Saskatchewan: Chief Game Guardian, Regina.
Yukon: Gold Commissioner, Dawson.

Colony of Newfoundland: Secretary, Game and Inland Fisheries Board, St. Johns.

PUBLICATIONS OF THE UNITED STATES DEPARTMENT O AGRICULTURE RELATING TO FUR-BEARING ANIMALS.

AVAILABLE FOR FREE DISTRIBUTION BY THE DEPARTMENT.

The Common Mole of Eastern United States. (Farmers' Bulletin 583.)
Economic Value of North American Skunks. (Farmers' Bulletin 587.)
The Domesticated Silver Fox. (Farmers' Bulletin 795.)
Trapping Moles and Utilizing Their Skins. (Farmers' Bulletin 832.)
The Muskrat as a Fur Bearer. (Farmers' Bulletin 869.)
Rabbit Raising. (Farmers' Bulletin 1090.)
Game Laws for 1921. (Farmers' Bulletin 1235.)
Fur Farming as a Side Line. (Yearbook Separate 693.)
Trapping on the Farm. (Yearbook Separate 823.)
Maintenance of the Fur Supply. (Department Circular 135.)
Annual Report of the Governor of Alaska on the Alaska Game Law, 1920. (Depar ment Circular 168.)
Directory of Officials and Organizations Concerned with the Protection of Birds an Game, 1921. (Department Circular 196.)

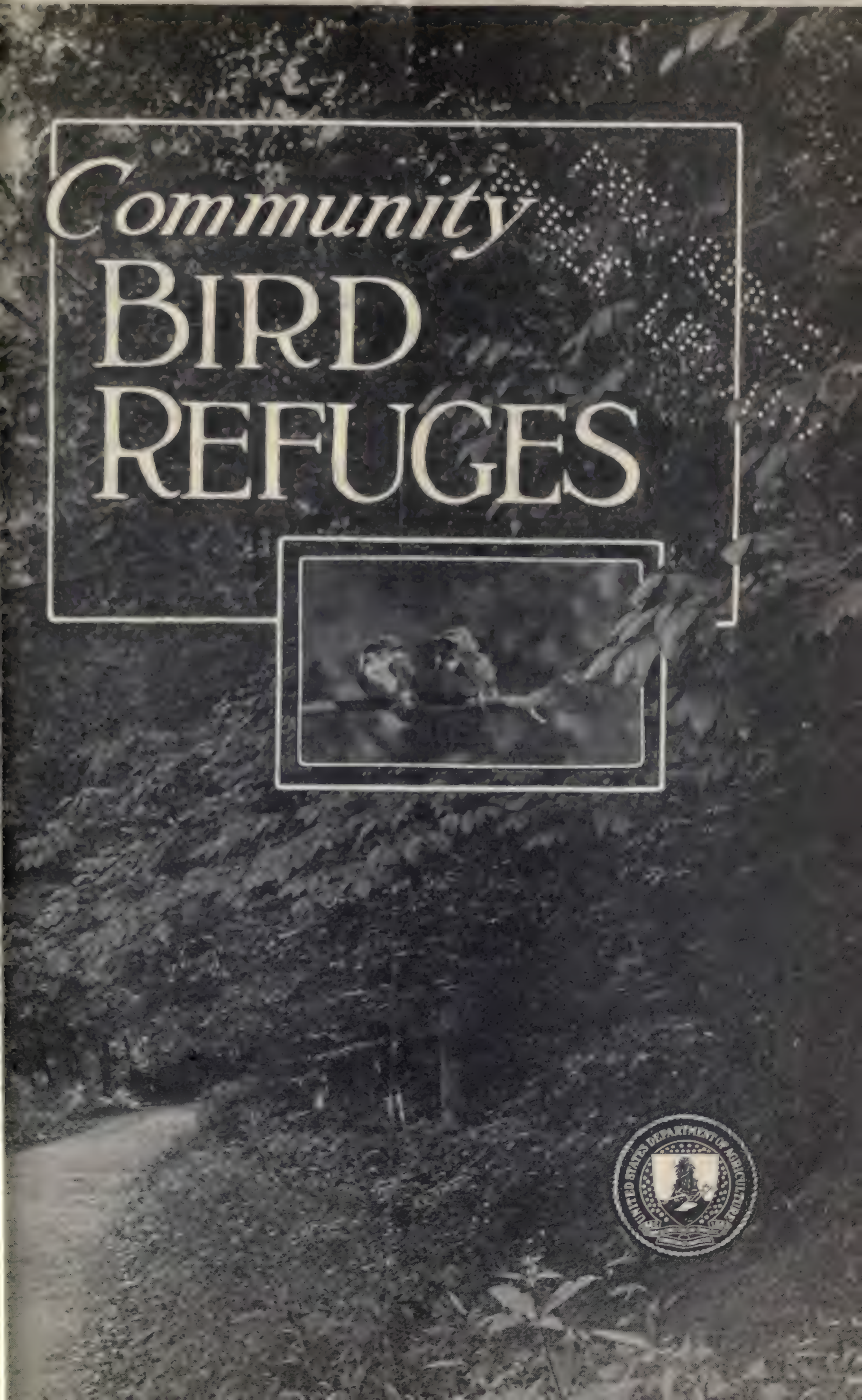
FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS, GOVERNMEN PRINTING OFFICE, WASHINGTON, D. C.

Deer Farming in the United States. (Farmers' Bulletin 330.) Price, 5 cents.

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1

FARMERS' BULLETIN 1239
UNITED STATES DEPARTMENT OF AGRICULTURE

Community BIRD REFUGES



BIRDS appeal strongly to the interests and affections of mankind. Not only do they charm by their graceful forms, harmonious colors, sprightly actions, and usually pleasing notes, but they have an even more important claim upon our esteem because of their great economic value.

Birds feed upon practically all insect pests. They are voracious, able to move freely from place to place, and exert a steady influence in keeping down the swelling tide of insect life.

For economic as well as for esthetic reasons, therefore, an effort should be made to attract and protect birds and to increase their numbers. Where proper measures of this kind have been taken an increase of several fold in the bird population has resulted, with decreased losses from depredations of injurious insects.

This bulletin, one of a series describing the best methods of attracting birds, deals with the establishment of community bird refuges, and is adapted for use throughout the United States.

Contribution from the Bureau of Biological Survey
E. W. NELSON, Chief
Washington, D.C. December, 1921

COMMUNITY BIRD REFUGES.

W. L. McAtee, *Assistant in Charge, Food Habits Research.*

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BIRD REFUGES ON FARMS.

FARMERS, more than any other element of the population, will be interested in the establishment and maintenance of effective bird refuges, for the welfare of crops and the commercial success of the farm are intimately related to the numbers and kinds of birds present and to their economic tendencies. In the case of certain species which are more or less injurious, control measures are sometimes necessary, but the great majority of birds vary from slightly to almost exclusively beneficial in their relations to the farm. The useful species merit the fullest protection and should be encouraged in every way.

The value of birds lies chiefly in their destruction of injurious insects. Leading an active life, they require much food, and are the most ravenous enemies of pests of this kind. The various groups of birds differ so much in habits that they feed upon practically all groups of insects; hardly an agricultural pest escapes their attacks. The alfalfa weevil has 45 different bird enemies; the army worm, 43; billbugs, 67; cotton-boll weevil, 66; brown-tail moth, 31; chestnut weevils, 64; chinch bug, 24; clover-root borers, 85; clover weevil, 25; codling moth, 36; cotton worm, 41; cutworms, 98; forest tent caterpillar, 32; gipsy moth, 46; horseflies, 49; leaf-hoppers, 120; orchard tent caterpillar, 43; potato beetle, 25; rice weevil, 21; seventeen-year locust, 38; twelve-spotted cucumber beetle, 28; white grubs, 67; and wireworms, 168.

In feeding on insect pests not only do birds take a great variety but they frequently destroy very large numbers. Often more than a hundred individuals are devoured at a meal, and in the case of small insects sometimes several thousand. With such appetites it is not surprising that occasionally birds entirely destroy certain insects locally. A number of cases are known in which trees, garden crops, and even farm fields have been entirely freed of insect pests by birds. On a 200-acre farm in North Carolina it was found that birds were destroying a million green bugs, or wheat aphids, daily.

On the average there are in the United States only about two birds to the acre, but where they are protected and encouraged it has been demonstrated that a very great increase over the normal bird population can be secured. No fewer than 59 pairs to the acre is the figure reached in the most successful of these attempts reported. At an estimated value of 10 cents each—a figure ridiculously low, but used to insure a safe minimum estimate—the birds of the United States prevent an increase in the annual damage done by insects of more than $400,000,000.

A particular farm may not have so large a bird population as it should, and therefore may not be deriving the benefit which is its due. The most effective means of increasing the number of birds is protection, and protection in its best sense is afforded by the establishment of bird refuges.

Bird refuges on farms have been most successful when established and maintained on a cooperative plan between the landowner or landowners and a State game commission, an Audubon society, a bird club, or a school. The owner agrees to the use of the land and acts as warden, and the other party to the contract furnishes and places posters (see illustration on back page), bird houses, and feeding stations, or even stocks the refuge, as in the case of reservations for game birds. The beneficial effect which the establishment of a bird refuge has upon trespass problems is a great advantage to the farmer. A State law authorizing game wardens to proceed agains trespassers on bird reservations greatly increases the effectivenes of private and cooperative bird refuges.

The cooperative bird preserve has been tried in many States a a means of establishing colonies of game birds, such as pheasants and the plan has invariably proved popular and successful. As method of protecting insectivorous birds it has been put into practic by schools, bird clubs, and Audubon societies in New Hampshire Connecticut, Illinois, and Minnesota, at least, and has been foun satisfactory and effective.

In creating a useful bird refuge, the first step is to insure adequat protection against all bird enemies; the second, to see that plent of nesting sites suited to the needs of various birds are available and the third, to improve food and water supplies, if necessary. In structions for accomplishing these results are contained in fiv earlier Farmers' Bulletins, of which No. 609, adapted to the whol country, relates to bird houses; and the following four, to method of attracting birds in various parts of the country: 621, Northeastern States; 760, Northwestern States; 844, Middle Atlantic States; and 912, East Central States (see map, fig. 1).

ROADSIDES.

Making bird refuges on farms, while of most direct interest to the farmer, is by no means the only activity along this line helpful to agriculture. Attracting birds to roadsides and right-of-ways, in particular, is of almost equal importance, and furnishes a leading reason for urging a treatment of these public and semipublic travel ways that will not only increase their bird population but make them more sightly. Both features will increase the value of the adjacent farms.

There exists in most parts of the United States either a superstition, a conviction, or a legal requirement that roadsides be shorn of their vegetation at least once a year. The result is that most country roads are very uninviting in summer. Hot and gray with dust, the highway stretches away before the traveler, often without a single tree to break the monotony of the view or afford relief from the rays of the sun. This baldness is brought about chiefly by two causes: (1) Fear that the roadside will unduly increase weeds and insect and rodent pests; and (2) lack of public spirit.

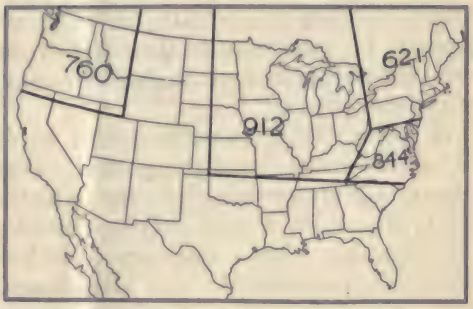

FIG. 1.—Areas treated by the several Farmers' Bulletins on methods of attracting birds.

Fortunately, we also have in this country examples of well-kept parkways and boulevards which border cultivated lands. Their ample parking is grown to grass and embellished with herbaceous flowering plants, shrubs, and trees. Yet the farm lands they border are neither overwhelmed by weeds nor devastated by insects and rodents.

The question of roadsides propagating vast numbers of noxious weeds may be viewed in more than one light. For instance, the mowing of waysides for long series of years has not done away with the need of cultivating adjacent crops; indeed it can not, for cultivation is necessary for other reasons than the destruction of weeds, as loosening, aeration, and water conservation. Furthermore, the amount of cultivation customarily given crops is sufficient to control all the weeds the land will grow, and this number is generally present, despite the razing of roadside growths. On the other hand, the lack of verdure and shade and the general dreariness of roadsides make the adoption of a different treatment of these most extensive public parkings very desirable. Placing vines upon fences and planting numerous shrubs and shade trees along the way will not only render the roads more attractive but will tend to keep down the dust. In plantings of this nature, omit the common barberry, which serves as an alternate host for wheat rust; gooseberries and currants which have a similar relation to the white pine blister rust; and the wild cherry, which is a favorable nursery for tent caterpillars.

There can be no doubt that suppression of roadside vegetation is a potent factor in restricting the numbers of birds, and the ever-increasing tendency to allow fence rows the minimum of space has the same effect. Farmers may gain a planting row about every field by the destruction of vegetation along fences, but they lose the services of the birds, their best allies in fighting insects.

Shrubby fence rows are among the best harbors and nesting places of small birds, and it is certain that encouraging an abundance of birds to live on farms by such plantings is a profitable policy. More should be done to beautify roadsides and fence rows, not only as a measure to contribute to the comfort and pleasure of man, but also substantially to increase a great economic asset—the bird population of the country.

In effect, windbreaks, so useful on farms in prairie regions, are but shrubby fence rows, magnified. Their utility in protecting crops from winds always is supplemented by that of furnishing nesting sites for birds, and a food-supplying function also may easily be added, since Russian olive, buffaloberry, and hackberry, all good bird foods, are highly recommended for windbreaks.

RIGHT-OF-WAYS.

A number of railroad companies have already made considerable effort to beautify their right-of-ways and station grounds. In some places the roads are paralleled for many miles by hedges, and the land on either side of the tracks is covered by beautiful turf. Hedges, shrubbery, and flower beds are common about the stations. If this planting could be directed in part, at least, toward attracting birds, it would be very effective and great good would be done. If the clumps of shrubs were formed of kinds furnishing bird food (see Table I) and more of them were placed along the right-of-ways, the hedges allowed to bear fruit, and the fence poles or possibly even some of the telegraph poles furnished with bird houses, thousands of birds could live where very few do now.

The suggestions made are by no means without practical value to the right-of-way itself. For instance, supplying bird boxes is the best method of preventing damage to poles by woodpeckers, which come anyway under present conditions and make their own homes. Hedges or fences densely covered with vines would decrease, if not entirely obviate, expenditures for the movable snow fences now extensively used.

The project of increasing the number of birds along right-of-ways should interest the agricultural development bureaus of railroads. The small birds that are most easily encouraged when shrubbery, nest boxes, and water supply are provided are chiefly beneficial, and increasing their numbers would result in great destruction of insects on adjacent farms, a very practical bit of agricultural improvement.

TABLE I.—*Preference of birds among genera of fleshy fruits.*[1]

Common name.	Scientific name.	Number of species of birds known to eat the fruit.[2]	Kinds of birds among those desirable to attract, that are most fond of the fruit.[3]
Juniper; red cedar	Juniperus	39	Yellow-shafted flicker, starling, evening grosbeak, pine grosbeak, purple finch, cedar waxwing, myrtle warbler, mockingbird, robin, eastern bluebird.
Greenbrier	Smilax	39	Cardinal, mockingbird, brown thrasher, catbird, hermit thrush, robin.
Bayberry	Myrica	73	Bob-white, downy woodpecker, yellow-shafted flicker, eastern phoebe, starling, meadowlark, chewink, tree swallow, white-eyed vireo, myrtle warbler, brown thrasher, catbird, Carolina wren, black-capped chickadee, hermit thrush, eastern bluebird.
Hackberry	Celtis	40	Yellow-bellied sapsucker, yellow-shafted flicker, cardinal, cedar waxwing, mockingbird, brown thrasher, robin, eastern bluebird.
Mulberry	Morus	52	Yellow-billed cuckoo, red-headed woodpecker, red-bellied woodpecker, downy woodpecker, kingbird, starling, Baltimore oriole, orchard oriole, cardinal, purple finch, scarlet tanager, cedar waxwing, red-eyed vireo, yellow warbler, mockingbird, catbird, wood thrush, robin.
Pokeberry	Phytolacca	49	Mourning dove, yellow-shafted flicker, kingbird, starling, cardinal, mockingbird, catbird, hermit thrush, gray-cheeked thrush, olive-backed thrush, robin, eastern bluebird.
Spicebush	Benzoin	17	Kingbird, red-eyed vireo, wood thrush, veery.
Sassafras	Sassafras	18	Bob-white, kingbird, red-eyed vireo, catbird, veery, robin.
Strawberry	Fragaria	46	Chewink, catbird, brown thrasher, wood thrush, robin.
Raspberry; blackberry.	Rubus	118	Ruffed grouse, bob-white, red-headed woodpecker, yellow-shafted flicker, kingbird, starling, Baltimore oriole, orchard oriole, pine grosbeak, song sparrow, fox sparrow, white-throated sparrow, chewink, California towhee, spurred towhee, cardinal, rose-breasted grosbeak, black-headed grosbeak, cedar waxwing, red-eyed vireo, mockingbird, catbird, brown thrasher, tufted titmouse, wren-tit, olive-backed thrush, wood thrush, robin, eastern bluebird.
Rose	Rosa	25	Ruffed grouse, sharp-tailed grouse, prairie chicken, bob-white.
Mountain ash	Sorbus	14	Red-headed woodpecker, Baltimore oriole, evening grosbeak, pine grosbeak, cedar waxwing, Bohemian waxwing, catbird, brown thrasher, robin.
Chokeberry	Aronia	13	Meadowlark, brown thrasher.
Red haw	Crataegus	33	Ruffed grouse, pine grosbeak, purple finch, robin.
Dwarf apples	Malus	([4])	Ruffed grouse, ringneck pheasant, red crossbill, pine grosbeak, purple finch, cedar waxwing, mockingbird, robin.
Juneberry	Amelanchier	40	Yellow-shafted flicker, Baltimore oriole, cedar waxwing, catbird, hermit thrush, veery, robin.
Wild cherry	Prunus	74	Ruffed grouse, bob-white, mourning dove, red-headed woodpecker, yellow-shafted flicker, kingbird, starling, Bullock oriole, Baltimore oriole, orchard oriole, evening grosbeak, purple finch, rose-breasted grosbeak, black-headed grosbeak, Louisiana tanager, red-eyed vireo, cedar waxwing, mockingbird, catbird, brown thrasher, olive-backed thrush, wood thrush, robin, eastern bluebird.

[1] Barberries (*Berberis*) and currants (*Ribes*) are omitted because they serve as alternate hosts of russt ttacking wheat and white pine, respectively.

[2] When 10 or more.

[3] Included on the basis of field observation or because fruit was found in 10 or more stomachs.

[4] Thirty-eight kinds of birds are known to feed on apples of various sorts, but it is not known just how nany seek the small-fruited flowering apples, which are the best to plant for birds.

TABLE I.—*Preference of birds among genera of fleshy fruits*—Continued.

Common name.	Scientific name.	Number of species of birds known to eat the fruit.	Kinds of birds among those desirable to attract, that are most fond of the fruit.
Sumac[5]	Rhus[5]	93	Ruffed grouse, bob-white, valley quail, downy woodpecker, red-bellied woodpecker, red-shafted flicker, yellow-shafted flicker, phoebe, starling, goldfinch, golden-crowned sparrow, chewink, white-eyed vireo, Audubon warbler, mockingbird, catbird, California thrasher, brown thrasher, Carolina wren, black-capped chickadee, Carolina chickadee, wren-tit, hermit thrush, robin, eastern bluebird.
Pepperberry	Schinus	11	Cedar waxwing, phainopepla, hermit thrush, varied thrush, robin.
Holly	Ilex	45	Ruffed grouse, bob-white, valley quail, yellow-bellied sapsucker, yellow-shafted flicker, cedar waxwing, mockingbird, catbird, brown thrasher, hermit thrush, robin, eastern bluebird.
Supple-jack	Berchemia	13	Mockingbird, robin.
Buckthorn	Rhamnus	16	Mockingbird, catbird, brown thrasher, robin.
Wild grape	Vitis	77	Ruffed grouse, bob-white, pileated woodpecker, red-bellied woodpecker, red-shafted flicker, yellow-shafted flicker, kingbird, starling, cardinal, cedar waxwing, mockingbird, catbird, brown thrasher, wood thrush, veery, robin, western bluebird, eastern bluebird.
Virginia creeper	Parthenocissus	39	Red-headed woodpecker, red-bellied woodpecker, yellow-bellied sapsucker, yellow-shafted flicker, starling, evening grosbeak, purple finch, scarlet tanager, red-eyed vireo, mockingbird, brown thrasher, tufted titmouse, hermit thrush, olive-backed thrush, gray-cheeked thrush, robin, eastern bluebird.
Buffaloberry	Shepherdia	16	Sharp-tailed grouse, pine grosbeak.
Silverberry, Russian olive, etc.	Elaeagnus	(6)	Sharp-tailed grouse, prairie chicken, cedar waxwing, catbird, robin.
Wild sarsaparilla	Aralia	14	Bob-white, robin.
Dogwood	Cornus	86	Ruffed grouse, bob-white, downy woodpecker, yellow-shafted flicker, red-shafted flicker, kingbird, starling, evening grosbeak, pine grosbeak, purple finch, white-throated sparrow, song sparrow, cardinal, cedar waxwing, warbling vireo, red-eyed vireo, catbird, brown thrasher, hermit thrush, olive-backed thrush, gray-cheeked thrush, wood thrush, robin, eastern bluebird.
Sour gum	Nyssa	36	Yellow-shafted flicker, starling, purple finch, cedar waxwing, gray-cheeked thrush, olive-backed thrush, robin.
Crowberry	Empetrum	16	Pine grosbeak, snowflake.
Bearberry	Arctostaphylos	16	Ruffed grouse, dusky grouse, valley quail, mountain quail, fox sparrow, wren-tit.
Huckleberry	Gaylussacia	35	Pine grosbeak, chewink, robin.
Blueberry	Vaccinium	67	Ruffed grouse, valley quail, kingbird, orchard oriole, pine grosbeak, chewink, cedar waxwing, catbird, brown thrasher, black-capped chickadee, tufted titmouse, hermit thrush, robin, eastern bluebird.
Mexican mulberry	Callicarpa	10	Mockingbird, brown thrasher.
Partridge berry	Mitchella	10	Ruffed grouse.
Elderberry	Sambucus	106	Valley quail, red-headed woodpecker, yellow-shafted flicker, eastern kingbird, Arkansas kingbird, black phoebe, starling, California towhee, white-crowned sparrow, rose-breasted grosbeak, black-headed grosbeak, phainopepla, red-eyed vireo, mockingbird, catbird, brown thrasher, California thrasher, wren-tit, olive-backed thrush, robin, western bluebird, eastern bluebird.
Snowberry	Symphoricarpos	25	Sharp-tailed grouse, evening grosbeak, pine grosbeak, varied thrush.
Black haw	Viburnum	28	Ruffed grouse, yellow-billed cuckoo, yellow-shafted flicker, starling, purple finch, rose-breasted grosbeak, cedar waxwing, catbird, brown thrasher, robin, eastern bluebird.
Honeysuckle	Lonicera	15	Bob-white, pine grosbeak, white-throated sparrow, catbird, brown thrasher, hermit thrush, robin.

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[5] Only nonpoisonous species of sumac are considered.

[6] Data given are based entirely on field observations; total number of birds eating the various species of *Elaeagnus* unknown.

COMMUNITY PARKINGS.

The attractiveness of community parkings, including those of cities and villages as well as of rural areas, may well be increased by the presence of an abundance of birds. This can be effected without in any way detracting from the utility of these reservations for their leading purposes. Making community parkings safe for birds is the first step; they must actually be havens of refuge. In this connection may be cited the admirable law of the State of Oregon, which provides that all incorporated towns and cities and all public parks and school grounds in the State shall be, without additional local or general legislation, bird and game sanctuaries.

MUNICIPAL PARKS AND PICNIC AND FAIR GROUNDS.

Picnic grounds, fair grounds, and parks may be improved as places of public gatherings, recreation, and education by increasing their bird population. Moreover, the alterations that improve a park as a bird haven may, and should, themselves be made to add to its attractiveness. For instance, water is used to enhance the beauty of most parks, and a water supply is one of the most potent attractions for birds. Bird baths (fig. 2) or bird fountains may take the form of small displays of water, which may be added to many parks without being obtrusive or in conflict with the general design.

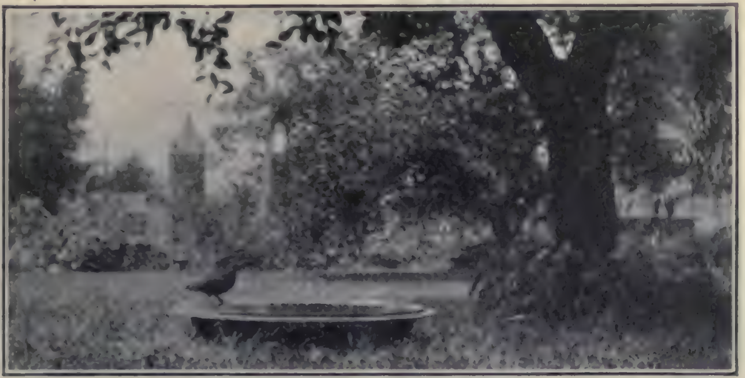

FIG. 2.—Flicker at a bird fountain. B805M

An artistic martin house, well placed in one of the small open lawns that most large parks contain (fig. 3), would not only increase the beauty and interest of the park, but would add to its dignity by suggesting a specific usefulness for the space. As for nest boxes for other birds, they may be so inconspicuously placed that the chief evidence of their presence would be the increased number of birds and the lessened injury to vegetation by insect pests. The perfection of specimen trees in parks and the work of the tree surgeon on imperfect trees make it necessary to supply nest boxes if the hole-nesting birds are to have any chance of inhabiting parks.

Feeding stations for birds are made in a number of sightly designs, and the principles upon which they are built allow of their being extensively varied or incorporated into other park structures. The greatest usefulness of feeding stations in parks, aside from the preservation of birds, is in rendering such places more attractive to the public in winter. The feeding of birds is carried on with most obvious results during the colder months, and adding this feature to parks appeals strongly to thousands of lovers of nature.

By means of feeding stations it is possible to attract to convenient observation points several species of the most interesting and valuable birds. Such stations are particularly pleasing to children. As evidence of the value of the method, the following statement of experience by Theodore Wirth, Superintendent of Parks, Minneapolis, Minn., is presented:

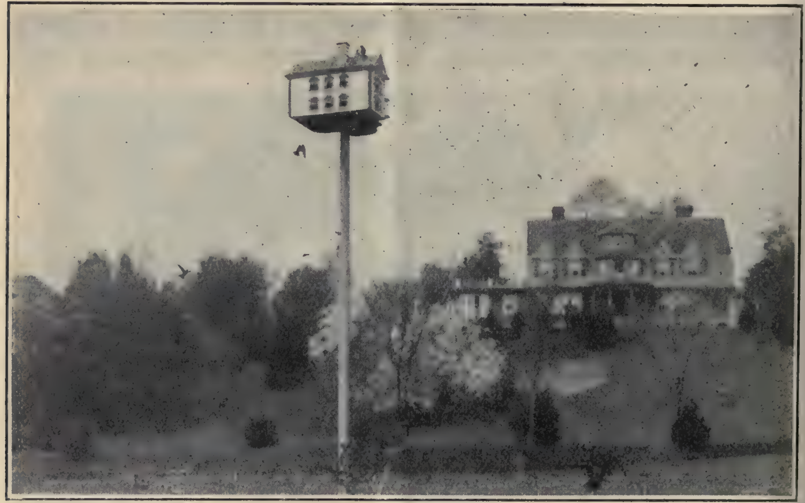

FIG. 3.—Martin house in parklike surroundings.

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> For the past five or six years we have maintained a number of feeding stations in various parts of our park system, with very satisfactory results. I give you a list of the birds which stay with us over winter. The permanent winter birds found in the vicinity of our parks are the chickadee, blue jay, white-breasted nuthatch, downy and hairy woodpeckers, and screech owl; winter visitors, the redpoll, tree sparrow, and junco; irregular winter visitors, the evening grosbeak, Bohemian waxwing, and snow bunting. It is safe to say that a large number of these species are staying in the parks on account of the food supplied them. The feeding of the wild birds in the parks is a great success and will be continued.

Supplying water, nest boxes, and winter food goes far toward making a bird haven, but it is important also to supplement the summer food. This can best be done by planting fruit-bearing shrubs and trees. Shrubs and trees are essential elements of park composition, but according to the judgment of bird lovers better choice is distinctly possible than that often made.

The guiding principle in park planning should be beauty, but it should not be a temporary or one-seasonal beauty. Hence it follows that shrubs and trees which produce colored fruits and retain them for long periods are preferable to plants whose chief decorative contribution is a short burst of bloom. Such shrubs are handsomer at all times after flowering and are particularly valuable in winter when every bit of color in the landscape is precious. They are valuable, moreover, in supplying bird food. The kinds preferred by birds are shown in Table I, and the species most suitable for various sections of the country are listed in the Farmers' Bulletins mentioned on page 5. (See also map, fig. 1.)

A few further suggestions as to the use of fruit-producing plants are not out of place. The ideal American park is natural woodland, modified and embellished, or a planting that follows natural lines. Informal treatment is almost universally preferred to formal. From the standpoint of bird attraction this is fortunate, since clipping shrubs either prevents or reduces the production of fruit and causes the plants to form such solid and dense surfaces that they are uninviting to birds. It may further be said in favor of untrimmed shrubbery that the normal form and beauty of the plants, together with the resultant play of light and motion, are preserved. With this treatment a park has naturalness and life; under formal treatment the suggestions are those of restraint and immobility.

SCHOOL AND COLLEGE GROUNDS.

Too often public-school grounds are bare and uninviting. How much better to clothe, shade, and adorn them with green. Flowers and trees will make the students more content with their surroundings, inspire them to better work, and enshrine the school grounds in pleasant memories delightful to recall in later years. Almost everything done to beautify the grounds will help to attract birds. Trees and shrubs cradle their young and supply much of their food.

The birds, the trees, and the flowers in themselves are a valuable educational resource, and are necessities for the proper conduct of classes in nature study, now deservedly so popular. Building and placing bird houses could well be part of such a course, and the winter feeding of the birds would attract living objects of interest during he dormant season of the trees and shrubs. All children like birds and will protect and encourage them if only their early steps are guided right.

The college campus, like the park, has suffered from formal landscape gardening. Wall-like hedges, closely cropped circles, triangles of shrubs, and mathematically designed edgings, beds, and gardens have gone far toward robbing school grounds of merit in the eyes of man, and have almost spoiled them for birds.

In campus planning it is desirable to take the birds into consideration for the same reasons as in park planning. In addition there is the very important objective of keeping up an important educational resource. There is hardly an advanced school in the country that does not offer one or more courses of bird study. The study of birds out-of-doors is essential to a good bird course, and this need should be kept in view by those in charge of college and school grounds. Sylvan campuses where formerly birds abounded have been so filled with buildings, so gardened and formalized, that birds are now scarce. If possible, some corner (preferably of original woodland, where that exists) should be allowed to run wild. Judicious addition of food-producing plants should be made there, and the campus in general improved for birds by allowing shrubs to make natural growths. Putting up nest boxes would make up for the hole-eliminating activities of the tree surgeon. Winter feeding would be very interesting and instructive to many students and could be carried on as part of the course of bird-study classes. Finally, the teacher of ornithology might well have an advisory capacity in relation to the planning and treatment of the campus.

CEMETERIES.

Cemeteries have the reputation of being good places for birds. The reasons, one must infer, are seclusion, freedom from disturbance, and an abundance of trees and shrubs. The last-named factor is by no means least, nor, on the other hand, so satisfactory as not to be susceptible of improvement. Selection of shrubs and trees with the needs of birds in mind not only would not interfere with the general plan of a cemetery, but would make it a still better resort for birds.

Formal landscape gardening is more prevalent (perhaps excusably so) in cemeteries than in other public reservations, yet there are very beautiful cemeteries in which formal composition plays little part. Here, as everywhere, the informal or naturalistic planting is most favorable to birds. Nest boxes can be added without being obtrusive, and bird fountains may be made to harmonize with the surroundings or even to serve as memorials.

The movement to convert cemeteries into bird sanctuaries and to improve them for the purpose is already well under way and is being fostered by the National Association of Audubon Societies. A pioneer in this work. H. S. Mann, Secretary of the Forest Lawn Cemetery Association of Omaha, Nebr., reports:

> We have been very successful in attracting birds to Forest Lawn Cemetery. The cemetery contains 320 acres, all fenced, and is located north of the city limits of greater Omaha. It has an abundance of trees and shrubbery, about 250 acres of the half section being unimproved at this time. A creek runs through the southern portion of the cemetery, and east and north of it are great stretches of wild lands.
>
> Bird houses, feeding stations, and baths have been erected in the cemetery. Quantities of tangled underbrush and small fruit-bearing bushes and vines have been set out and preserved for the birds. With these attractions, free from annoyance of cats, hunters, and children at play, it is a paradise for birds.
>
> Bird students visit the cemetery frequently, as a larger number and a greater variety of birds may be found within its sacred inclosures than anywhere else in this section of the country, excepting perhaps in the great Fontenelle Forest Reserve of 2,500 acres on the Missouri River adjoining the city on the south.

RESERVOIRS.

The grounds surrounding reservoirs of drinking water usually are well fenced and carefully guarded to minimize contamination. This results in freedom from disturbance, a boon so highly appreciated by birds that in itself it goes far toward making these places satisfactory bird havens. Such reservations can be greatly improved for this purpose, however, by the use of bird houses and by proper planting, measures which will be in no way deleterious to the water supply, but which will greatly benefit the birds and through them the vegetation of the reserve and of the adjacent country.

Reservoirs other than for drinking water usually can be sown to aquatic plants, thus making them attractive to many water birds. The character of the planting will depend on circumstances; if a marshy margin is permissible, the place may be made into an excellent resort for wild fowl. If only submerged plants are desired and as clean a growth as possible, sago pondweed may be planted. Broader leaved plants furnish much greater surface for the lodgment of silt and the growth of algae. The methods of propagating a variety of aquatic plants for the use of wild fowl are described in Department Bulletins 205 and 465.[1]

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[1] Bull. 205, U. S. Dept. Agr., Eleven Important Wild-Duck Foods; Bull. 465, Propagation of Wild-Duck Foods.

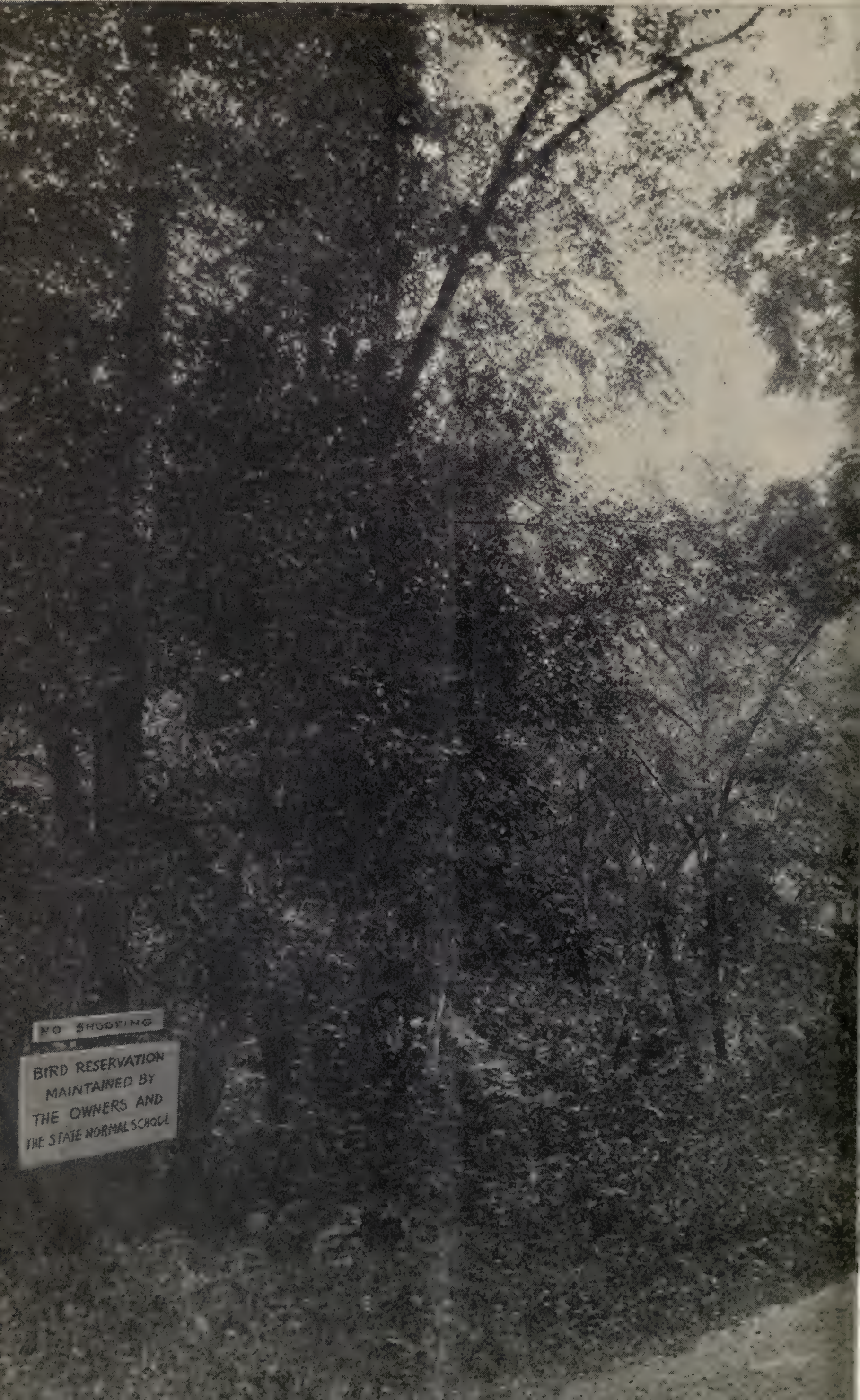
PUBLICATIONS OF THE U. S. DEPARTMENT OF AGRICULTURE RELATING TO THE PROTECTION AND ATTRACTION OF WILD BIRDS.

AVAILABLE FOR FREE DISTRIBUTION BY THE DEPARTMENT.

Eleven Important Wild-Duck Foods. (Department Bulletin 205.)
Propagation of Wild-Duck Foods. (Department Bulletin 465.)
Bird Houses and How to Build Them. (Farmers' Bulletin 609.)
How to Attract Birds in Northeastern United States. (Farmers' Bulletin 621.)
How to Attract Birds in Northwestern United States. (Farmers' Bulletin 760.)
How to Attract Birds in the Middle Atlantic States. (Farmers' Bulletin 844.)
How to Attract Birds in the East Central States. (Pennsylvania to 100th meridian). (Farmers' Bulletin 912.)
Game Laws. (Annual publication, that for 1921, Farmers' Bulletin 1235.)
Community Bird Refuges. (Farmers' Bulletin 1239.)
Directory of Officials and Organizations Concerned with the Protection of Birds and Game. (Annual publication, that for 1921, Department Circular 196.)
Our Shorebirds and Their Future. (Separate 642, Yearbook 1914.)
The Great Plains Waterfowl Breeding Grounds and Their Protection. (Separate 723, Yearbook 1917.)
Federal Protection of Migratory Birds. (Separate 785, Yearbook 1918.)
Conserving Our Wild Animals and Birds. (Separate 836, Yearbook 1920.)

FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS, GOVERNMENT PRINTING OFFICE, WASHINGTON, D. C.

Preliminary Census of Birds of the United States. (Department Bulletin 187.) Price, 5 cents.
Second Annual Report of Bird Counts in the United States, with Discussion of Results. (Department Bulletin 396.) Price, 5 cents.
Plants Useful to Attract Birds and Protect Fruit. (Separate 504, Yearbook 1909.) Price, 5 cents.
Bird Day in the Schools. (Biological Survey Circular 17.) Price, 5 cents.
National Reservations for the Protection of Wild Life. (Biological Survey Circular 87.) Price, 5 cents.
Chronology and Index of the More Important Events in American Game Protection, 1776–1911. (Biological Survey Bulletin 41.) Price, 10 cents.
Decision of the Supreme Court of the United States Sustaining the Constitutionality of the Migratory-Bird Treaty Act. (Department Circular 102.) Price, 5 cents.


NO SHOOTING
BIRD RESERVATION
MAINTAINED BY
THE OWNERS AND
THE STATE NORMAL SCHOOL

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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1240

How to GROW RICE IN THE SACRAMENTO VALLEY

1862 1889

THE COMMERCIAL PRODUCTION OF RICE in California began in 1912, when 1,400 acres were grown. By 1920 the area had increased to 162,000 acres.

Rice growing in California is confined mostly to the heavy clay and clay-adobe soils of the lower Sacramento Valley, where abundant water is available for irrigation. Rice requires high temperatures during the growing season, a dependable water supply for irrigation, level land with an impervious subsoil, and good drainage.

Fields on which rice is to be grown should be leveled and the checks laid out carefully, so that water can be applied to them easily and uniformly. Uneven submergence of rice in the checks causes uneven ripening and lowers the market value of the crop.

Land on which rice is to be sown is usually spring-plowed and is then disked and harrowed or the clods crushed with drags. The seed is either drilled or sown broadcast. If the land is to be submerged continuously after seeding to control water grass, it is safer to sow the seed broadcast than to drill. Slacking the clods on drilled fields continuously submerged after seeding may cover the seed too deeply and result in poor stands. Early shallow seeding at the rate of 115 to 130 pounds on new land and 125 to 145 pounds on old land usually gives best results. The leading varieties of rice in California at present are Caloro, Early Wataribune, Colusa, and Onsen.

Weeds, particularly water grasses, are the most troublesome pests in California rice fields. They can be controlled to a considerable extent by deep early submergence.

This bulletin supersedes Farmers' Bulletin 1141, Rice Growing in California, issued September, 1920.

Washington, D. C. Issued March, 1924

HOW TO GROW RICE IN THE SACRAMENTO VALLEY.[1]

By Jenkin W. Jones, *Agronomist, Office of Cereal Investigations, Bureau of Plant Industry.*

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HISTORY.

INVESTIGATIONS begun by the United States Department of Agriculture in the spring of 1909 and continued for three years provided information which indicated the commercial possibilities of rice culture in California. The first commercial rice crop was grown in California in 1912 on Stockton clay-adobe soil in the Sacramento Valley, near Biggs. The high acre yields and large profits from this crop of 1,400 acres received wide publicity, which stimulated interest and resulted in the rapid expansion of the California rice industry. In 1914, 15,000 acres were sown, while in 1915 the crop was grown on 34,000 acres. The high price of rice during the World War naturally caused a further increase in acreage and production. The maximum so far was reached in 1920, when 9,720,000 bushels of rice were produced on 162,000 acres. The acreage in 1921 and 1922 was less than in 1920, the estimate for 1922 being 140,000 acres with a production of 8,260,000 bushels.

Rice is grown in California only in the San Joaquin and Sacramento Valleys. Most of the crop is produced in the Sacramento Valley in Butte, Glenn, Colusa, Sutter, and Yolo Counties.

IMPORTANCE OF THE RICE CROP.

The area on which rice can be profitably grown in the United States is much more limited than that on which most of the other cereal crops can be produced with profit. Rice is, however, well adapted to certain sections.

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[1] For a more complete discussion of rice production in California, together with the etails of the experiments on which many of the recommendations in this bulletin are ased, see Jones, Jenkin W., Rice experiments at the Biggs Rice Field Station in Caliornia, U. S. Dept. Agr. Bul. 1155, 1923.

During the 5-year period from 1917 to 1921 the average annual area sown to rice in the United States was 1,083,000 acres and the average annual production 41,107,000 bushels. In the same period the average annual acreage sown to rice in California was 125,244 acres and the average annual production 7,481,000 bushels. During this period California has produced more than one-sixth of the total annual rice crop of the United States on less than one-eighth of the total annual acreage.

The average yield per acre in California is considerably higher than that obtained in other large rice-producing States. The 10-year average yield from 1910 to 1919 for California was 53.9 bushels; for Arkansas, 40.9 bushels; for Texas, 33.8 bushels; for Louisiana, 33.6 bushels; and for the United States, 35.7 bushels per acre.

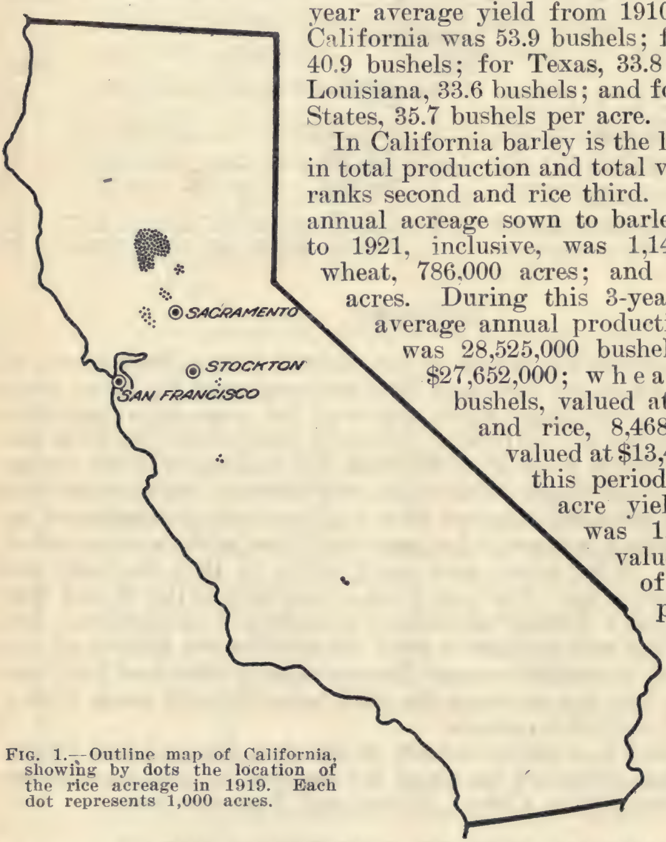

FIG. 1.—Outline map of California, showing by dots the location of the rice acreage in 1919. Each dot represents 1,000 acres.

In California barley is the leading cereal in total production and total value. Wheat ranks second and rice third. The average annual acreage sown to barley from 1919 to 1921, inclusive, was 1,141,000 acres; wheat, 786,000 acres; and rice, 146,000 acres. During this 3-year period the average annual production of barley was 28,525,000 bushels, valued at $27,652,000; wheat, 11,529,000 bushels, valued at $20,434,000; and rice, 8,468,000 bushels, valued at $13,486,000. For this period the average acre yield of barley was 1,200 pounds, valued at $24.75; of wheat, 880 pounds, valued at $22.66; and of rice, 2,610 pounds, valued at $95.31. The average acre value of rice during this 3-year period has been 3.8 times that of barley, 4.2 times that of wheat, 2.3 times that of corn, 4.4 times that of oats, and 3.2 times that of grain sorghum.

By contrast, rice sown on one-eighth of the average barley acreage has produced nearly half as much agricultural wealth. Sown on less than one-fifth of the average wheat acreage rice has produced nearly two-thirds as much agricultural wealth. Rice is grown chiefly on land which was used for wheat and barley culture prior to the introduction of rice, so under rice culture this land is much more productive than it was when wheat and barley were grown.

RICE-GROWING REGIONS.

There are five main rice-producing regions in the United States:

(1) The coastal plains of the Carolinas and Georgia, where rice has been grown for more than 200 years. Prior to the Civil War rice growing was a profitable industry in this section, but at present the crop is of little agricultural value.

(2) The alluvial bottom lands along the Mississippi River in Louisiana, where rice growing began commercially in 1865. The irrigation water for this section is obtained mostly from the river by means of siphons.

(3) The broad level prairie region of southwestern Louisiana and southeastern Texas, where rice growing began on a commercial scale about 1885. The irrigation water for this section is obtained by powerful pumps from sluggish streams or bayous, which provide drainage for the prairies. Water is also pumped from deep wells. This is the most important rice-producing region in the United States.

(4) The prairie region of eastern Arkansas, where rice growing began commercially in 1905. The irrigation water for this section is pumped from deep wells.

(5) The interior valleys of California, where rice growing began on a commercial scale in 1912. The irrigation water for this section is obtained largely from the Sacramento and Feather Rivers by gravity and by pumps.

REQUIREMENTS OF THE CROP.

Successful rice culture is dependent upon (1) high temperatures during the growing season, (2) a dependable water supply during the period of irrigation, (3) soils that are comparatively flat or level and underlain with an impervious subsoil, and (4) good surface drainage.

In tropical and subtropical countries rice is the standard cereal crop, and it is also grown in the warmer sections of the Temperate Zone. British India, China, Japan, Burma, and the Philippine Islands are the leading rice-producing countries of the world.

In California continuous submergence of the land to a depth of 4 to 6 inches for 90 to 140 days each year is necessary for the production of profitable rice crops. It is also necessary to flood the land after sowing, to germinate the rice seed. A dependable supply of irrigation water, therefore, must be available when needed.

The clay and clay-adobe soils of California, which have an impervious subsoil from 3 to 6 feet below the surface, are best adapted to rice culture. Such soils require less water to produce a crop than do the lighter soils. After draining in the fall, these heavy soils usually dry out and crust at the surface more quickly than lighter soils, thus making possible the use of heavy machinery in harvesting the crop. Level land can be prepared for rice irrigation at a much lower cost per acre than slightly rolling or rough land. The larger checks on level land are also more economical to harvest than the small checks necessary on uneven land.

Good drainage is as essential in rice culture as in wheat culture, for without adequate drainage it is difficult to obtain good stands in the spring and practically impossible to drain the land thoroughly for harvest when the crop is nearing maturity. Poorly drained fields are hard to cultivate and expensive to harvest. It therefore is essential to have good surface drainage if maximum yields are to be produced at a minimum cost.

CLIMATE.

In the Sacramento and San Joaquin Valleys the summers are hot, with low humidity. The hottest months are June, July, and August, with maximum temperatures ranging from 105° to 115° F. A daily range in temperature during these months of 40° is not uncommon. The nights are comparatively cool, even during the hottest months. The winter months are usually mild, though freezing temperatures are not uncommon during December, January, and February. These are also the months of highest precipitation. All precipitation is in the form of rain. The average annual rainfall at the Biggs Rice Field Station for the nine-year period from 1913 to 1921 was 21.7 inches.

The average evaporation from a free water surface from April 1 to October 31 was 42.8 inches. Strong winds seldom occur, though there is often considerable wind during the early spring and late fall months.

SOILS.

The rice crop in California is grown on various soil types. The heavy clays and clay adobes which are underlain with an impervious subsoil at depths ranging from 18 to 36 inches appear to be best adapted to this crop. These heavy soil types are hard to cultivate. If plowed when too wet they bake; if too dry they turn in large clods, which are difficult to reduce. These soils require from 4 to 6 acre-feet of water to mature a rice crop, while lighter soils may require from 7 to 10 acre-feet. Heavy soils when drained in the fall usually dry out and crust at the surface in from 10 to 14 days, so that they will support heavy harvesting machinery, while most light soils dry more slowly and do not crust at the surface as quickly, so that it is often necessary to harvest in the mud. Harvesting under such conditions is very expensive.

ROTATIONS.

The rice industry of California is comparatively young, and no definite system of rotation is yet being followed. The heavy soils on which rice is grown and the high water table during the submergence season make it difficult to find crops that can be grown profitably in a rotation with rice. The nearest approach to a rotation system at present is on land on which two or three rice crops have been grown. These rice crops are followed by spring or summer plowed fallow on which wheat or barley is fall sown, and then rice is again grown for one year. By this method only one rice crop is grown on the same land once in three years after the original crops on new land. A second method is to alternate a rice crop and fallow. The rice stubble is irrigated and pastured or spring-plowed for fallow; then prepared for rice the following spring. Some do not fallow but leave the land uncropped and uncultivated until it is prepared for rice the following spring.

At the Biggs Rice Field Station attempts have been made to grow cultivated crops in rotation with rice, but neither corn, grain sorghums, cotton, nor beans have produced a profitable crop. Until more information is available on other crops it seems advisable to use the crops that were produced before rice growing began, i. e., wheat and barley. These crops mature before the water table has risen sufficiently to interfere with growth. Some very good yields of wheat and barley have been reported on fallowed rice land, although some growers do not think that these crops are profitable under such conditions. These growers prefer to alternate rice and fallow or to have two rice crops and one fallow. The growing of wheat or barley following rice without fallowing is seldom practiced, for the yields obtained are usually low.

FERTILIZERS.

The three plant-food elements most likely to be deficient in soils are nitrogen, phosphorus, and potash. When deficient, these elements can be added to the soil in the form of manure and commercial fertilizers.

Fertilizers are not now used on the California rice fields. Each year, however, more growers are making inquiry regarding the possibility of maintaining or increasing yields by the use of fertilizers. The water used for irrigation in California is comparatively pure and therefore adds but little, if any, plant-food elements to the soil.

The new rice lands are very productive, but yields are usually materially lower with each successive crop. The reduced yields may be due to a lack of plant-food elements, competition with weeds, poor physical condition of the soil, lack of humus, poor drainage, unfavorable conditions for soil microorganisms, or other causes.

Fertilizer experiments with rice at the Biggs Rice Field Station indicate that the Stockton clay-adobe soil is deficient in nitrogen. It is quite possible that other rice soils of California are also deficient in this element. Nitrogen can be added to the soil as commercial fertilizer or by growing a leguminous crop to be plowed under. The second method should be followed wherever possible, as it adds humus and thus improves the physical condition of the soil as well as supplying nitrogen. Decaying humus also helps to make other plant-food elements more readily available. No legumes are now known to do well on California rice lands, but such crops may be found.

Rice yields at the Biggs Rice Field Station have been materially increased by the application, just before seeding, of manure at the rate of 1 ton per acre, of ammonium sulphate at the rate of 100 pounds per acre, of dried blood at the rate of 160 pounds per acre, and of cottonseed meal at the rate of 280 pounds per acre. The increased yields were sufficient to give a fair profit after deducting the cost of the fertilizer and its application.

Investigations indicate that rice may use nitrogen in the form of ammonia, while most cultivated plants use nitrogen in the form of nitrates. Rice is grown on submerged land which is unfavorable for the formation of nitrates, but some ammonia compounds are formed. The application of nonnitrogenous fertilizers at the Biggs Rice Field Station failed to increase yields materially. The nitrogenous fertilizers if applied in too great quantity are likely to cause lodging; they therefore should be used with care.

The fertilizer experiments at Biggs indicate that, except for manure, ammonium sulphate applied at the rate of 100 pounds per acre or dried blood applied at the rate of 160 pounds per acre produced the largest and most profitable increases in yield. These fertilizers quite possibly can be used with profit on commercial fields.

WATER SUPPLY.

The Sacramento and Feather Rivers, which are fed by melting snows in the Sierra Nevada Mountains, supply most of the water used for rice irrigation in the Sacramento Valley. Private companies divert the water from these rivers by gravity or by large pumps. The water is distributed to the growers by a system of canals and laterals and sold on an acre-foot basis or at an annual charge per acre. Very little rice is irrigated from deep wells in the Sacramento Valley, but in the San Joaquin Valley deep wells are often the only source of water. Deep wells are expensive to dig, equip, and operate and should not be depended upon for rice irrigation until they have been thoroughly tested. If wells are to be used they should be ready to operate before the rice is sown. In California it is necessary to apply water to germinate the seed, and thereafter irrigations must follow often enough to keep the land moist and in good condition for crop growth or the water must be held continuously.

PREPARATION OF LAND FOR IRRIGATION.

Most of the land on which rice is grown in California is comparatively level, with a gentle slope varying from 2 to 5 feet per mile. Such land can be prepared for rice irrigation with little expense. A competent surveyor should be employed to locate the supply ditches, the drainage ditches, and the field levees. The improper location of these ditches and levees often causes serious losses. The supply ditches should be properly located and large enough to furnish ample water when needed. The drainage system should be adequate to dispose of the water promptly when desired. The usual method of connecting the various points on a contour line is to follow the rodman with a plow, the plowed furrow indicating the base of the levee. A tractor drawing 10 or 12 plows then makes one round, backfurrowing to the furrow made by the team. This provides loose ground for building the levees. Sharp turns in levees should be avoided when possible, for such turns make the levees hard to build and the crop difficult to harvest.

The outside levees should be well constructed and higher than the field levees, to avoid seepage and loss by overflowing. The outside levees often serve as one bank of the supply or drainage ditch and when so used are often built with a Fresno scraper. The interior or field levees are usually made with a checker drawn by one or two tractors, depending upon the size of the checker or of the tractors used. The checkers are usually equipped with some device for raising and lowering the rear end, which enables the operators to lift it when moving from levee to levee and in a measure to control the size of the levee. When the ground is rough or trashy the checkers are often weighted so that they will push enough soil together to form a good levee. On large fields these outfits can build from 10 to 15 miles of levees in a day.

The checkers are usually homemade and are variable in size. The runners for the sides are generally made of 3-inch by 12-inch plank 16 to 24 feet in length and are lined with steel. The front end is from 10 to 18 feet wide on the bottom, and the rear end is 3 to 6 feet wide on the bottom. The sides are made 2 to 3 feet high and are set on a batter, or slant, of ¼ to 1, the tops sloping outward. A tractor-drawn checker is shown in Figure 2.

It requires more power to pull a large checker than a small one, but the levees constructed by a large checker are much more serviceable and economical than those poorly built with a small checker. Poorly constructed levees often result in low yields of rice of poor quality. Levees on small fields are often built with a ditcher or V crowder.

The checkers are pulled with the wide end forward, the loose surface soil being drawn through to the small end. This makes a levee from 12 to 24 inches high and from 4 to 6 feet wide at the base.

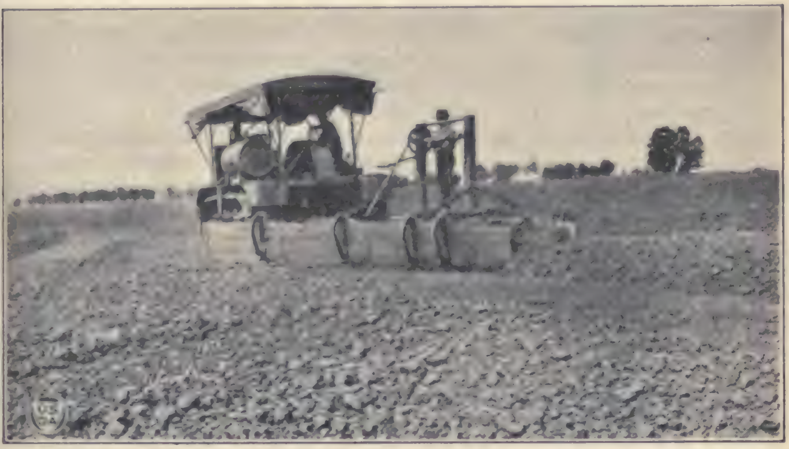

FIG. 2.—A tractor-drawn checker used in constructing levees in California rice fields.

It is impossible to connect the field levees and outside levees with the tractor and checker, owing to the space needed for turning. Therefore, the ends of the field levees must be built to connect with the outside levees by using the Fresno scraper. This work should be done before the fields are seeded.

At convenient places in the levees irrigation boxes should be installed to facilitate irrigating. The boxes should be placed deep enough so that the bottom boards will not hold the water back when the fields are draining. The depth of water is controlled by shutters which are held in a vertical position across the openings of the irrigation boxes. By taking out or putting in a narrow board shutter the water can be lowered or raised as desired.

Leveling the land within a check is not commonly practiced in California. Where high spots are removed to fill in low places, the crop on the fills grows very rank and does not mature well, while on the scraped places the growth is stunted.

On old rice land an unequal depth of submergence in the check does not materially affect the date of maturity of the rice crop, but on new land unequal depths of submergence may result in the uneven ripening and inferior quality of the grain.

SEED-BED PREPARATION.

In preparing the seed bed the land should be spring-plowed 4 to 6 inches deep as early as it can be worked to advantage. In a week or 10 days after plowing the land may be disked or harrowed. A few days later it is dragged with a heavy drag. If the land is very cloddy, it is often dragged two or three times. Disking and harrowing are often omitted and the clods are crushed with heavy drags. The time that elapses between plowing and the other cultural operations gives the weather an opportunity to reduce the clods; in fact, the action of the weather on clods during these intervals is often more effective than cultivation in preparing a good seed bed. A light rain followed by a few warm days is very effective in reducing clods.

Very little California rice land is fall-plowed. The reason for this is that rice is harvested late in the fall, in October and November, and rains may occur before threshing is completed. By the time harvest is completed the land is usually too wet to plow. Some rice land is fall-plowed in exceptionally dry years. Fall-plowed land, through the action of rain and sun during the winter months, is easily reduced to a good seed bed the following spring. On the other hand, weeds, especially canary grass and wild oats, start growth on fall plowing during the late winter and early spring months and are difficult to kill unless the land is replowed shallow in the spring, which makes the seed-bed preparation expensive. If weed growth is killed on fall-plowed land before sowing, the cost of preparing a seed bed on spring-plowed and on fall-plowed land is about equal. Yields are similar on fall and spring plowing.

A slightly rough seed bed is preferable to a finely pulverized one when rice is sown broadcast and not harrowed. Finely pulverized seed beds have a tendency to run together after irrigation and remain cold and unfavorable for germination and early growth, while one which is slightly rough does not run together so much and is more favorable for germination and early growth. The seed bed should not be too finely pulverized, nor should it be so rough that it is difficult to see the drill marks if a drill is used.

Rice sown on disked stubble does not yield as well as that on plowed land. The disked stubble provides better conditions for the growth of cat-tails, spike rush, umbrella plants, slender aster or ironweed, and other weed pests. It pays to kill all growth before sowing rice.

VARIETIES TO GROW.

There are two main groups of rice, glutinous and nonglutinous. The nonglutinous rices are grown most extensively in all rice-producing countries. Based on method of production there are two general types of rice, lowland and upland. Based on kernel shape and size, rices are classed as long-grain, medium-grain, and short-grain varieties. The commercial varieties grown in California are nearly all short-grain rices, and all are of the lowland or irrigated nonglutinous type. The short-grain rices are hardy, yield well, and usually mill well, but the best varieties require a comparatively long growing season. Early rices are desirable in California, but in addition to earliness they must have stiff straw and the ability to produce high yields of good milling quality.

Many early rice varieties are known, but earliness, stiff straw, high yield, and good milling quality are seldom combined in one variety. Earliness is easy to secure, but the desirable combination of other characteristics with it is hard to find. Earliness in rice, as in most crops, is often associated with low yields and inferior quality instead of high yields and good quality.

The varietal experiments at the Biggs Rice Field Station show that the short-grain rices are better adapted to California conditions than the medium or long grain varieties. The early and midseason short-grain varieties are grown most extensively in California and produce much better crops than the medium and long grain rices.

A variety of rice known to be adapted to the section in which it is to be grown should be sown in preference to some new and unknown variety. New varieties should not be sown extensively until they have been tested in comparison with the leading local varieties. Frequently the sowing of a new variety before it has been tested results in considerable loss to the growers. The new variety may not be adapted to the section, or may have a weak straw, or may produce low yields of poor quality. Each year some new early-maturing variety appears in California which, according to press statements, will revolutionize the rice industry, but in the past these varieties have had one or more weak points which have prevented them from coming up to the advance notices. It is best to use home-grown seed of an adapted variety which is known to produce good yields of good quality.

The commercial varieties in California are quite badly mixed. The varieties become mixed from volunteer growth when growers change varieties. The varieties are also mixed in threshing when a grower produces more than one variety. These mixtures are undesirable, because the different varieties usually vary in kernel size and mature at different dates, which results in an inferior quality of rice.

It would probably pay growers to maintain seed plats on their farms on which they could rogue out the mixed varieties and inferior plants. If the crop from such plats is carefully threshed and cleaned, growers could produce their own seed of a known variety of good quality and free from mixtures. Growers who do not wish to take the trouble to raise seed rice in a seed plat can usually obtain good seed from someone who specializes in seed production. It is discouraging to see a pure-line variety, the development of which has required the spending of considerable time and money, become badly mixed after being grown commercially for two or three years.

The leading varieties of rice in California are discussed in the paragraphs which follow.

WATARIBUNE.

Wataribune (fig. 3) was the leading rice variety grown in California from 1912 to 1917. This rice was brought to California by the United States Department of Agriculture in 1909. Wataribune (sometimes known as Late Wataribune in California) yields well on new and on old rice land, mills well, and is the hardiest variety grown in that State. It stools well on new and on old land, heads and ripens uniformly, and has a reasonably stiff straw. It does not shatter easily nor is it difficult to thresh. The only objection to this variety is its long growing season, about 168 days from first irrigation to maturity on old land. It is not extremely late on old land, however, as it usually matures from October 15 to 20 if sown reasonably early in the spring. If growers are equipped to handle their crop quickly, this variety is usually satisfactory. Like all other varieties it requires a longer growing season on new than on old land.

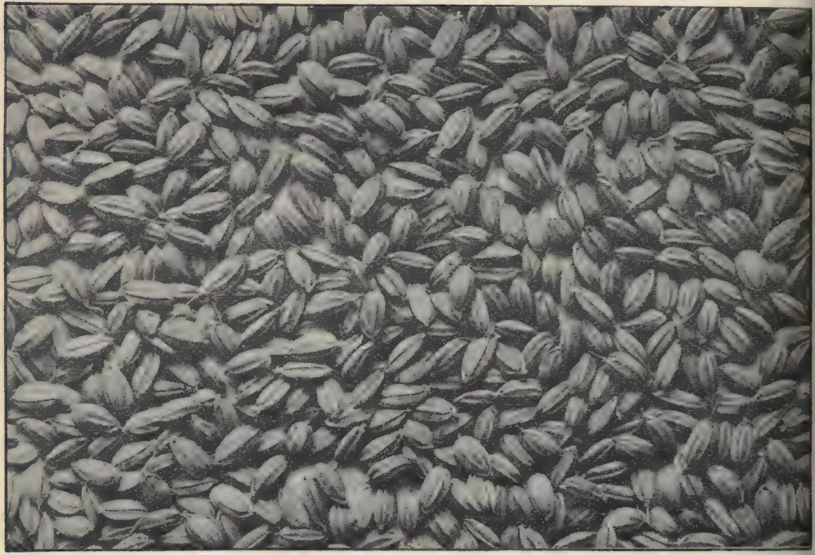

FIG. 3.—Seed rice of the Wataribune variety. (Natural size.)

The grain of Wataribune rice is short and broad. The hull is light yellow and has a light yellowish awn, or beard. The beards may drop before the rice is harvested or at harvest time, so that only a few of them are present in the threshed rice.

EARLY WATARIBUNE.

Early Wataribune is one of the leading varieties in California. This variety was introduced from Japan by W. K. Brown in 1913. Early Wataribune is not a pure variety but is slightly mixed and consequently does not head and mature uniformly. It yields well on new and on old land and matures about a week to 10 days earlier than Wataribune. It mills well and is popular with both growers and millers. On old land it requires about 158 days from the first irrigation until the crop is mature.

The grain of Early Wataribune is short and broad. The hull is light yellow and has a light yellowish beard. The beards usually drop before the rice is harvested or at harvest time, so that the threshed rice is usually beardless.

CALORO.

Caloro rice was developed at the Biggs Rice Field Station and was first distributed in 1921. It is now the leading variety grown in California. It is a pure-line variety which heads and ripens uniformly and yields well on both new and old land. It matures about 4 days earlier than Early Wataribune. The grains are short and broad and, like those of Early Wataribune, have short yellowish beards, which usually drop before the crop is harvested and threshed. Caloro heads quickly, ripens evenly, and usually yields better than Early Wataribune. On old rice land Caloro requires about 155 days from the first irrigation until the crop is mature.

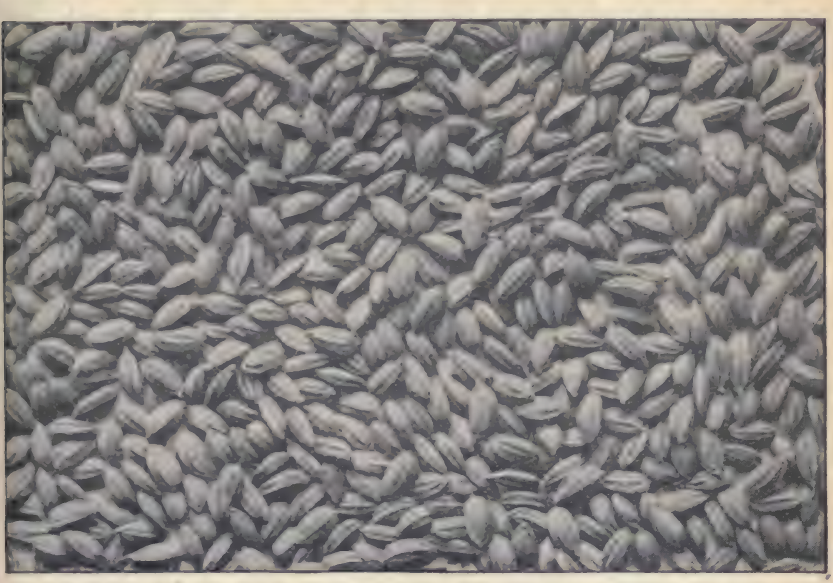

FIG. 4.—Seed rice of the Colusa variety (C. I. No. 1600). (Natural size.)

COLUSA.

The Colusa variety (C. I. No. 1600) is an early short-grain rice distributed by the Biggs Rice Field Station. It was developed from a selection originally made at the Crowley Rice Experiment Station, Crowley, La. Colusa is 10 days to two weeks earlier than Early Wataribune, requiring about 145 days from the first irrigation until the crop is mature on old rice land. It yields well on new land but not on old rice land unless the latter is quite productive. Colusa is especially well adapted for growing on new land, but is inclined to lodge if the land is very rich. The grains are short and broad, light yellow, and beardless.

ONSEN.

The Onsen variety is an early short-grain rice introduced from Japan by a Japanese in 1918. Onsen is about two weeks earlier than Early Wataribune and yields well on new land but has a marked tendency to lodge. On old land Onsen does not, as a rule, yield as well as Early Wataribune or Caloro, but appears to be better adapted in some sections than Colusa. Onsen is not a pure-line variety but is mixed. Most of the crop is very similar to Colusa, though the grains may be slightly larger. They are short and broad, mostly beardless, and the hull is light yellow. On old rice land Onsen requires about 142 days from the first irrigation until the crop is mature.

SEED.

After deciding upon the proper variety to grow, one which is adapted to the locality, has stiff straw, and yields and mills well, it is important to have a supply of good seed of that variety. Good seed rice should be graded and cleaned with a fanning mill. It should be free from red, immature, dehulled or broken rice or the seeds of other rice varieties or weeds. Good seed rice should be well filled and uniform in size. Uniformity in size and ripening is more important in rice than in other cereals, because the value of rough rice is based upon the percentage of head rice obtained in milling. Larger yields of head rice are obtained from well-matured rough rice consisting of grains of uniform size of one variety than from poorly matured rough rice consisting of grains of various sizes and a mixture of varieties.

The use of seed rice containing immature, dehulled, or cracked grains often results in poor stands which ripen unevenly and produce low acre yields of inferior quality. Grasses and weeds increase the cost of production, reduce yields, and lower the market value of the crop produced. Mixed varieties that mature at different times and vary in kernel size are very undesirable in rice.

Poor stands can often be improved by sowing in an early-maturing variety of the same type as that originally sown, but this practice is not to be recommended except in extreme cases, and the crop produced should not be used for seed the following year. Economy in crop production is desirable, but it is false economy to use poor seed rather than to pay a slightly higher price for good seed.

If there is any doubt regarding the germinating power of the seed, it should be tested before it is sown. To make a germination test, count out several lots of 100 seeds from the seed to be sown, place the lots separately between blotting papers, and keep moist at a temperature of 75° F. for about 10 days. Then count the seeds that have strong sprouts and figure the percentage of germination. If seed of low germinating power must be sown, the rate of seeding should be materially increased.

SEEDING.

METHOD OF SEEDING.

Rice is sown with a drill or broadcast with an end-gate seeder. Both methods of seeding are commonly used. On well-prepared seed beds the drill distributes the seed more evenly and at a more uniform depth than is possible with broadcast seeding, and ordinarily less seed is required. Drilled rice usually germinates and grows more uniformly than broadcast rice. On comparatively rough and rough seed beds rice is generally sown broadcast. On such seed beds drilling is too slow and expensive, and the seed is not placed at a uniform depth or covered evenly. Drilling is slow, uniform, and expensive, while broadcasting is rapid, not uniform, and inexpensive. Broadcast rice is not usually harrowed after sowing, for the first irrigation water will slack enough clods to bury the seed.

DATE OF SEEDING.

The best date to sow rice in California varies with the soil and climatic conditions from year to year. Rice may be sown between April 15 and June 1, but for the best results with the usual method of irrigation and when soil conditions and temperature permit, it should be sown as early as possible. There is less danger of losses from fall rains when the crop is sown early and matures early.

A variety of rice has a tendency to mature within a certain period regardless of the date of seeding, but yields are higher from the early dates of seeding. In a date-of-seeding experiment at the Biggs Rice Field Station in which Wataribune rice was sown as early as soil conditions permitted and at 15-day intervals thereafter until June 1 there was a marked decrease in yield with each successive date of seeding.

The earliest date of seeding produced a 9-year average of 400 pounds per acre more than the second date, and 500 pounds per acre more than the third date. The late-sown rice was of poorer quality each year than the early-sown rice.

It has been observed also that early-sown commercial fields as a rule produce higher yields of better quality than late-sown fields.

Light soils are warmer early in the spring than heavy soils and for this reason can be sown earlier. Rice sown in a cold soil and irrigated with cold water during a period of low temperatures usually germinates poorly, and often three weeks elapse before the plants emerge. Under such circumstances seeding should be deferred until conditions are more favorable for germination and growth. Under such variable conditions as exist in California no best date of seeding can be recommended. However, late-maturing varieties should be sown as early as weather and soil conditions permit, from April 10 to 25, midseason varieties may be sown from April 15 to May 15, and early varieties from April 20 to May 20.

RATE OF SEEDING.

The rate of seeding depends upon—

(1) The variety used. Early-maturing varieties stool less than late-maturing ones, and for this reason more seed of them should be sown.

(2) Quality of seed used. Poorly matured seed does not germinate as well as fully matured seed, and for this reason seed of inferior vitality should be sown at a higher rate than well-matured seed.

(3) Fertility of the soil. On rich soils less seed is required than on poor soils, because the crop will stool more on rich soil.

(4) Condition of the seed bed. Less seed is required on a well-prepared seed bed than on a poorly prepared one, because the percentage of germination is higher on a well-prepared than on a poorly prepared seed bed.

(5) Method of irrigation. Good stands are dependent upon proper irrigation when the crop is being irrigated up. Small heads of water during the initial floodings often result in poor stands, owing to the long time required to cover and drain the fields. If the water must stand on the fields for several days, the rate of seeding should be heavier than when it can be irrigated and drained properly.

(6) Date of seeding. Less seed is required to obtain an optimum stand late in the season than earlier, for conditions are then more favorable for prompt germination and growth.

(7) Method of seeding. As a rule, less seed is required on well-prepared seed beds when drilled than when sown broadcast.

(8) Drainage. Good drainage is essential to obtain good stands. If the drainage is poor the rate of seeding should be increased, so that if the seed rots there will be less injury to the stands.

(9) New or old land. Less seed is required to obtain optimum stands on new than on old rice land, because conditions are more favorable for germination and the rice stools better. Thin stands may induce excessive stooling, resulting in nonuniform heading and ripening and often in low yields of poor quality. Good stands prevent excessive stooling and tend to produce uniform heading and ripening and high yields of good quality.

Late-maturing varieties should be sown at the rate of 100 to 110 pounds per acre on new land and 120 to 130 pounds on old land. Midseason varieties should be sown at the rate of 115 to 125 pounds on new land and from 125 to 135 pounds on old land. Early varieties should be sown at the rate of 120 to 130 pounds on new land and from 130 to 145 pounds per acre on old land.

DEPTH OF SEEDING.

The depth at which rice should be sown depends upon—

(1) Character of the soil. Rice can be sown deeper on a light warm soil than on a heavy cold one, because the seed will germinate and emerge more quickly.

(2) Condition of the seed bed. On poorly prepared seed beds the seed should be sown shallower than on well-prepared beds, because if sown 2 inches deep on a poorly prepared seed bed the first irrigation water will slack the clods and cover the seed to a depth of perhaps 3 to 4 inches, which is too deep for best results.

(3) Drainage. On land that can not be well and promptly drained, shallow seeding is preferable to deep seeding, because rice covered with soil and water germinates poorly and much of the seed rots, but it germinates well under water if the seed is not covered with soil and conditions are favorable for germination.

In a depth-of-seeding experiment at the Biggs Rice Field Station in which rice was sown 1, 2, and 3 inches deep, that sown at the 1-inch depth produced an average acre yield of 250 pounds more and that at the 2-inch depth a yield of 370 pounds more than that sown at the 3-inch depth.

On light warm soils rice should be sown 2 to 3 inches deep, and on heavy, cold, but well-drained soils, 1 to 2 inches deep. On poorly drained land and poor seed beds, it is better to have some seed on the surface than to sow too deeply.

IRRIGATION.

On the heavy soils used for rice culture in California it is necessary to apply water to germinate the seed. The usual irrigation season is therefore divided into two periods. The first period consists of frequent irrigations, followed by drainage, to germinate the seed and to keep the crop growing well until about 30 days after emergence, when the second period, or period of submergence, should begin. Good stands are occasionally obtained by early seeding on light soils without irrigation to germinate the seed, but such cases are rare. On heavy soils rice should not be sown until water for irrigation is available.

During the first irrigation period when the water is applied to start germination, the water, soil, and air temperatures are usually much lower than they should be to insure prompt germination. Usually two irrigations are necessary to get the plants up. With the first irrigation it is not so essential that the water be drained from the field quickly, though it should not remain on the land more than 2½ days. After the first irrigation the soil should not be allowed to dry out enough to injure the germinating seeds.

The second irrigation is the critical one, and unless the field is irrigated quickly and drained promptly the stands obtained are very likely to be thin and disappointing. When the crop is up it should receive frequent irrigations to keep the soil in good condition for growth. This will require an irrigation once each week or 10 days, depending upon the soil and climatic conditions, until the rice is submerged. At the last irrigation preceding submergence, the water should be drained off very slowly in order to stretch the plants in the low spots so that they will not be injured by deep water when submergence begins.

Irrigation experiments at the Biggs Rice Field Station show that the rice land should be submerged to a depth of 6 inches 30 days after the plants have emerged. During the submergence period enough water should be entering the checks at all times to replace the losses by seepage, evaporation, and transpiration, and to maintain the desired depth of submergence.

When the rice is submerged, water flows from check to check, and normally there is little danger of any part of the field becoming stagnant if the water is maintained at a constant depth. Therefore it is not necessary, on lands that are free from alkali, to have water overflowing the last check into a drainage ditch. Water is valuable and should not be wasted in this way.

Profitable rice crops can not be grown in California without submerging the land continuously for 90 to 140 days. Rice grown on land kept moist but not submerged is dwarfed and produces small heads and low yields of poor quality.

The quantity of water required to produce a crop of rice depends on—

(1) The topography of the land. Land with natural sloughs or drainage courses passing through it requires more water than land with no natural drainage, because some water will pass through the levees into these sloughs and be lost.

(2) The character of the land. Light open soils require more water to produce a rice crop than heavy soils underlain with an impervious subsoil.

(3) The levee construction. Fields with poorly constructed outside levees lose more water by seepage than fields inclosed by well-constructed levees.

(4) The irrigator. Good irrigators appreciate the value of water and do not waste it; others apparently do not appreciate its value and often waste it. Basing water charges on the volume delivered rather than fixing them at a flat rate per acre would tend to conserve the water and to confine rice growing to the heavy soil types, on which about 5 acre-feet of water are required to produce a rice crop.

Other methods of irrigation are discussed under the heading of water-grass control.

DRAINAGE.

The importance of good drainage should not be underestimated in rice production. Poorly drained land is usually expensive to cultivate, difficult to obtain good stands on, and seldom produces maximum yields. Weeds, such as cat-tails, umbrella plants, spike rush, and grasses, are more difficult to control on poorly drained than on well-drained land. Harvesting is usually more expensive on poorly drained than on well-drained land, and there is often a loss due to overripeness which results in shattering. Before the rice is sown or irrigated it is advisable to provide drainage for the low places in the field, so that it can be well drained during the flooding season and before harvest.

Good judgment must be used in deciding when the rice crop is ready to drain for harvest. No set rule can be given as to the proper time to drain, because so many factors must be considered. Some soils dry quickly after draining, others very slowly. It is evident, therefore, that the water should be held longer on soils that dry quickly than on those that dry slowly. As a rule, heavy soils dry slowly, but they crust or bake at the surface much more quickly than light soils. For this reason, some light soils should be drained earlier than heavy soils, because more time is required to form a crust at the surface which will support harvesting machinery. The weather has a marked influence upon the date of draining. Naturally, it takes longer for the soil to dry with poor drying weather than with good drying weather. It usually takes from 10 to 18 days after draining until the land is dry enough to support harvesting machinery. The levees should be cut in many places so that all water can be drained from the low spots in the field.

Prior to draining the land for harvest, no water should be allowed to enter the fields for about a week. This gradual lowering of the water is desirable because rapid draining has a tendency to weaken the rice straw and cause lodging. Large quantities of drainage water also may damage crops located on lower lands.

Rice should be drained early enough to permit the ground to become dry, so that it will support harvesting machinery by the time that the crop is practically mature. It is usually ready to drain when the heads are well turned down and the lower kernels on the heads are in the soft-dough stage. At this time the upper two-thirds of the kernels on the heads are usually turning yellowish in color.

The rice varieties grown in California require about 42 days from first heading until they are mature. About 10 days elapse from the time the first heads appear till the crop is fully headed. The first heads are ripe about 10 days after full heading, and the crop is fully mature about 22 days after the first heads ripen.

After the rice heads are well turned down, they appear to mature as well in shallow as in deep water. When rice is drained too early the yield is reduced and some kernels are immature, resulting in inferior quality. When drained too late there is often a loss due to overripeness, with resulting shattering during harvest and possible lowering of quality due to sun cracking.

More rice is probably damaged in California as a result of draining too early than from draining too late. Rice drained at the right time is ready to harvest before it is overripe and yet not immature. At this stage it yields best and mills well.

Drainage ditches should be cleaned during the slack season prior to draining for harvest, so that the fields can be drained promptly if necessary.

Harvesting in the mud will soon take the optimism out of an optimist and materially reduce the profits of an otherwise profitable crop.

For many years little attention was given to the drainage problem, but now several drainage districts have been organized. Considerable draining has been done and more will be done from year to year. With better drainage the duty of water will probably be reduced.

Drains should be kept open during the winter months. This will prevent water-logging and the accumulation of alkali salts in the surface soil. Good drainage also aids in the aeration of the soil, which is distinctly beneficial to rice lands.

HARVESTING THE CROP.

Rice is ready to harvest usually in from 10 to 18 days after draining. At this time the heads should be well turned down, yellowish in color, and the lower kernels on the heads in the hard-dough stage. If harvested before this stage of development, the quality may be lowered and the yields reduced by the presence of immature kernels. If harvested after this stage there may be a loss from shattering and sometimes from inferior quality due to sun cracking.

Binders are used in harvesting the rice crop. Most of the binders are equipped with small auxiliary engines, so that they will continue to cut even though the bull wheel slides in the wet or muddy ground. Binders without the auxiliary engines are often used on the drier ground. Three or four horses or mules pull the binders. Small tractors are often used on 8-foot binders when cutting conditions are favorable. The best stock and binders should be used in opening the checks, i. e., making the first round.

Binders and engines should be repaired before harvesting starts, so that costly delays will not be experienced after the harvesting begins. Usually one binder should be available for each 50 to 60 acres of rice.

SHOCKING.

The short-grain rices are the principal varieties grown in California. When the kernel of short-grain rice is ripe, the straw and leaves are still partially green. The harvested rice should, therefore, be put in small shocks to facilitate prompt and proper curing. About one day after rice is cut the bundles should be put in small shocks of six to eight bundles each (fig. 5). The bundles should be set firmly on the butts and the shocks well built, to avoid falling or blowing over. Slow curing and protection from the sun improve the milling quality of rice. Rice shocks usually dry slowly in California and for this reason are seldom capped, for the caps delay curing too long. Capped shocks hold the moisture from dews and light showers and thus delay threshing in the morning. Capping shocks is expensive, and since the caps interfere with morning threshing and prevent the shocks from curing well in a reasonable length of time, it is best not to use them except in extremely wet weather.

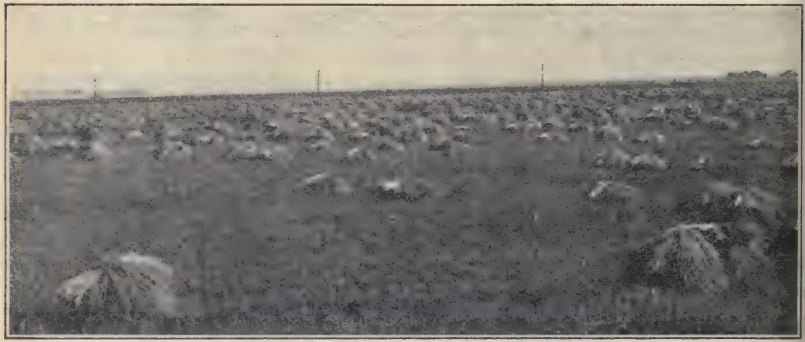

FIG. 5.—A field of shocked rice in the Sacramento Valley.

It is poor practice to stand one bundle up by itself, for most of the grain is thus directly exposed to the sun, dews, light showers, and rapid drying, which may result in sun cracking and inferior milling quality.

THRESHING.

In threshing rice the quantity rather than the quality of the work done in a day is too often the standard of a job. Much rice is often wasted because a suitable platform or canvas is not provided to catch the shattered grain. Separators are not well cleaned before changing from one variety to another or from farm to farm, and, as a result, varieties become badly mixed and weed seeds are scattered. Many grains are cracked and the hulls removed by the high speed of the cylinders and by improper adjustment of the cylinders and concave teeth. The cylinder teeth should center between the concave teeth. If the cylinder teeth are to one side or the other, or if the cylinder has side play, the grains of rice will be cracked. Separators and tractors should be overhauled before threshing time in order to avoid costly delays.

Rice should be threshed when the grain is hard and the straw reasonably dry. This will require from 7 to 14 days in the shock, the length of time depending upon weather conditions. Threshing early in the morning, when the grain and straw are damp, often results in poor separation and the loss of grain. Damp rice when stored in sacks may heat and serious losses may result. Careful threshing insures a better grade of rice and larger profits.

Threshing sets should be located on high ground and the sacks of rice put on a bed of straw. (Fig. 6.) The high ground and straw beneath the sacks help to protect the rice in case heavy rains occur before the rice is banked out of the field. Rice should be banked out as fast as threshed; i. e., if 1,000 sacks are threshed per day the same number should be banked out, because there is little chance to get rice out of the field at a reasonable cost after heavy rains. It can, however, be gotten to the warehouse if it is on or near a public road.

DRAYING.

As stated, all rice should be banked out of the field the same day that it is threshed. It should not then be allowed to accumulate along the roadsides, but should be hauled immediately to the warehouse. The cost per sack is much less for banking out of the field and trucking to a warehouse when conditions are favorable than after a heavy rain, when the fields and roads may be practically or totally impassable.

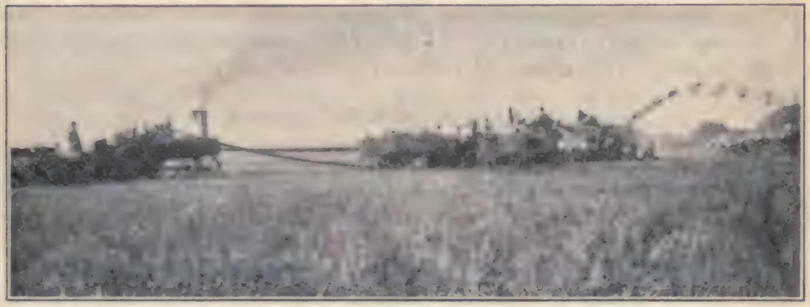

FIG. 6.—Threshing rice in the Sacramento Valley.

The rice crop is not saved until it is in the warehouse. In the past, during wet autumns considerable rice has been damaged in piles along the roadsides or in the fields. This loss could have been avoided by moving the rice promptly until it was warehoused.

WEEDS.

Weeds are a serious menace to the rice industry of California. Most of the land in rice is badly infested with these pests, which materially decrease yields. Plants that inhabit wet places find conditions in the rice fields ideal for their development. Most of these plants have the characteristic weed habits, which include hardiness, abundant seed production, and shattering, which make them difficult to control or eradicate.

Weeds increase the cost of production, reduce yields, and if the seeds are mixed with the threshed grain lower its price.

Weeds are introduced into the rice fields in five ways: (1) By sowing their seeds with the seed rice, (2) by floods and irrigation water, (3) by birds and other animals, (4) by the wind, and (5) by threshing outfits. Introduction by some of these methods can be avoided. Seed rice containing weed seeds should not be sown. Troublesome weeds should not be allowed to grow along canal banks or in waste places. Animals pastured on foul land should not be transferred to clean land. Threshing outfits should be well cleaned before moving from a weedy to a weed-free farm or field. When only a few weeds appear on the roads, levees, ditch banks, and in the field, they should be pulled by hand or mowed before they mature seed. Weeds are well established throughout the California rice-producing area, so the problem is not, except on new or second-year land, how to prevent their introduction, but how to control or eradicate them.

The worst weeds in the California rice fields are barnyard grasses (*Echinochloa crusgalli* and varieties), cat-tails (*Typha latifolia*), spike rush (*Eleocharis palustris*), sprangle-top (*Leptochloa fascicularis*), umbrella plants (Cyperus), red-stem (*Ammannia coccinea*), red rice (*Oryza rufipogon*), canary grasses (*Phalaris paradoxa* and *P. brachystachys*), crabgrass (*Digitaria sanguinalis*), slender aster (*Aster exilis*), and cheat (*Bromus secalinus*).

BARNYARD OR WATER GRASSES.

Barnyard grasses (*Echinochloa crusgalli* and varieties), which are locally known as water grasses, are the most troublesome weeds in the California rice fields. There are several varieties of water grass, some bearded and others beardless. These varieties differ considerably in date of maturity, height, and size of stems, heads, and seeds. For convenience in discussion of the varieties in this bulletin, they have been placed in four groups:

(1) The early red varieties which grow from 1½ to 2½ feet high, stool heavily and have small stems with rather short, compact heads and small seeds. These varieties have purplish green stems, leaves, and heads and mature and drop most of their seed before the rice is headed.

(2) The midseason varieties, which grow from 3 to 6 feet high, stool quite heavily and have rather coarse stems with comparatively long, loose heads and midsized seed. These varieties usually have purplish green stems, leaves, and heads, the purple color being less pronounced than in the early varieties. They mature and drop most of their seed before the rice crop is fully headed.

(3) The late white varieties, which grow from 2 to 5 feet high, stool heavily and have rather coarse stems with comparatively long, compact heads. One variety has very large seeds, while another has much smaller seeds. The late white varieties do not shatter as readily as the two groups just mentioned, and much seed is present in the threshed rice. The heads of the late white varieties are yellowish green and usually mature before but often with the rice crop.

(4) Other late varieties, which grow from 2½ to 4 feet tall and stool heavily, have midsized stems with comparatively compact heads and midsized to large seeds. One of these varieties has short, stiff red beards, and another is beardless. The plants and heads are about the same color as the rice. They usually mature at the same time as the rice crop.

The barnyard grasses are annuals which usually stool abundantly and produce a large number of viable seeds. These grasses are quite widely distributed in the United States and are usually found growing along sloughs, irrigation ditches, drainage ditches, on low land, and in marshy irrigated fields. They grow exceptionally well in the California rice fields.

Water-grass seed germinates with the rice, and for about 10 days after emergence the rice grows faster than the grasses. In about two weeks, however, the grasses are taller than the rice, and most of them can be distinguished from it by their purplish green color. The late white varieties are yellowish green and until they begin to head are not easily distinguished from rice by one who is unfamiliar with water grasses.

CONTROL OF WATER GRASSES.

The many varieties of barnyard grass present in the rice fields, ranging in maturity from June 15 to October 20, combined with the long growing season of rice, rather poor drainage, and the apparent ability of the grass seeds to remain in the soil from year to year until conditions are favorable for germination, make their control or eradication a very difficult problem. The problem is further complicated by the fact that much of the rice is grown by tenant farmers, who often have slight interest in preventing the spread of weeds. Several methods for the control of water grasses are suggested in the paragraphs which follow.

Hand pulling.—Water grasses can be destroyed by hand pulling if cut below the crown of the plant, removed from the field, and placed on dry land. Hand weeding is practicable and profitable on new land or on land where the grass plants are few, but this method is too expensive when the grasses are thick. The grasses should be pulled at least once every three weeks from June 15 to September 15 if they are to be kept under control. When the water-grass plants are not numerous hand weeding is effective and pays. It should be rigidly practiced on new land.

Rotation.—Cultivated crops grown in rotation with rice, if kept free from weeds, are helpful in reducing water grasses, but usually such crops on rice lands are unprofitable.

Fallowing.—Spring, summer, or early-fall irrigation germinates water-grass seeds, and the young plants can then be killed by shallow plowing before seed is matured. To insure germination the land should be irrigated and plowed shallow two or three times during the summer. This method is naturally quite expensive. Deep plowing buries the water-grass seeds so deep that they do not germinate but appear to lie dormant in the soil until they are again brought to the surface by later plowing. Water-grass seeds apparently do not rot readily until after germination, and they germinate only when weather and moisture conditions are favorable.

Fall flooding.—Flooding in the fall will germinate some water-grass seed, and the plants may then be killed by frost before seed is matured. This method, however, is not of much practical value.

Submergence.—Control of water grass by early submergence is comparatively new in California, and there are at least three methods which are used quite extensively. In method No. 1 the rice is sown broadcast and submerged immediately to a depth of 5 to 7 inches.

The water is then held continuously at this depth until the crop is ready to drain for harvest. In method No. 2 the rice either is sown broadcast or drilled; then flooded and drained two or three times until the rice emerges. It is then submerged 5 to 7 inches deep and the water held continuously at this depth until the crop is ready to drain for harvest. In method No. 3 the land is submerged 5 to 7 inches deep and the rice sown broadcast in the water, the water then being held continuously at this depth until the crop is ready to drain for harvest.

Each of these methods of irrigation is quite satisfactory in controlling the growth of the early and midseason varieties of water grass, but these irrigation methods apparently do not check materially the growth of the late white varieties. When these irrigation methods are used and the white grasses are not too thick it seems advisable to pull them by hand, to prevent them from increasing and making control by irrigation ineffective.

Methods Nos. 1 and 3 appear to be more effective in the control of grasses than method No. 2.

Five problems in connection with these methods of rice irrigation are now being studied by the United States Department of Agriculture on the rice field station at Biggs and by the California Agricultural Experiment Station at Cortena, Colusa County. These are (1) the best date of seeding and submerging, (2) the most effective depth of water to hold, (3) the best rate of seeding to use, (4) the best seed-bed preparation, and (5) a comparison of the effectiveness of the three methods of irrigation. The recommendations which follow are based on four years' observations on commercial fields and two years' experimental results at the Biggs Rice Field Station.

In method No. 1 the rice should be sown broadcast from May 1 to 10 at the rate of 150 pounds per acre. It should be sown on a smooth seed bed, so that little seed will be covered by slacked clods when the land is submerged. The depth of submergence should be kept constant, at from 5 to 7 inches, as fluctuations in depth may let the grass emerge. Some grass usually is present on high spots which are covered with shallow water, and the levees are usually covered with a dense growth of water grasses and other weed pests.

In method No. 2 the land should be reasonably well prepared, though it need not be as smooth as for method No. 1. The rice can be sown either broadcast or drilled as early as conditions permit at the rate of 150 pounds per acre and irrigated up. When the rice plants appear the field should be submerged to a depth of 5 to 7 inches and the water held continuously until the crop is ready to drain. Fluctuations in the depth of water should be avoided if the grass is to be controlled. Rice will germinate under water, but it does not germinate well if covered with soil and water.

In method No. 3 the land should be reasonably well prepared and submerged to the desired depth of 5 to 7 inches. The water slacks the clods and levels the surface. The rice should then be broadcast in the water from May 1 to 10 at the rate of 140 pounds per acre and the water held at this depth until the crop is ready to drain for harvest.

Method No. 1 is just as effective as method No. 3 in checking the grasses, but more seed is required to obtain a good stand. Method No. 2 is not as effective in controlling the grasses as the other methods, but in this method the stand is determined before the crop is submerged. There is some satisfaction in knowing early in the season whether or not a good stand has been obtained.

The water-grass varieties, with the possible exception of the late white ones, apparently are not water plants and are suffocated when young if water is held on them from 5 to 7 inches deep, while the rice and some white water grasses germinate, stretch to the surface of the water, and make a normal growth. The slender, elongated, rice leaf when it reaches the water surface lies prostrate on it for many days before it becomes erect. At this time strong winds may form waves, and often many plants are pulled up and washed to corners of the checks along the levees. If scum forms on the water surface and bakes on top before the rice has emerged, it often prevents many plants from emerging, with resulting thin stands. Notwithstanding these difficulties the methods of irrigation described are quite effective in the control of water grasses and make it possible to grow profitable rice crops on land which is too foul for rice growing by the usual or old irrigation method. On clean land it is best to follow the old system of irrigation, as unfavorable temperatures and deep water may cause poor stands. On the other hand, continuous submergence of clean land may prevent it from becoming foul.

CAT-TAILS.

Cat-tails (*Typha latifolia*), locally known as tules, grow in sloughs and drainage ditches, on poorly drained land, and in rice fields. The cat-tail is a perennial which spreads by seeds and creeping rootstocks. The cylindrical head of the cat-tail, which ranges in length from 6 to 12 inches, is borne at the end of a round stalk. Each head contains thousands of seeds which are readily spread by wind and water. Deep moldboard plowing followed by thorough drying of the soil is very helpful in the control of cat-tails. Good stands of rice have a tendency to prevent cat-tails from entering a field. They usually appear first in the rice fields in low spots or along the levees where the soil has not been well cultivated and stands of rice are poor. Disking rice stubble instead of plowing it in preparing the seed bed for rice provides favorable conditions for the growth of cat-tails and other weeds. Good seed-bed preparation pays, if for no other reason than that it helps to control cat-tails.

SPIKE RUSH.

The spike rush (*Eleocharis palustris*), locally known as wire-grass, grows on poorly drained land, in shallow ditches, and on field levees and establishes itself in rice fields in the corners of checks and elsewhere where cultivation and drainage are usually poor. The spike rush is a leafless perennial plant which produces seeds at the tapering end of a single round stem. The stems vary in diameter from one-sixteenth to one-eighth of an inch. The spike rush spreads by means of underground rootstocks. It will completely crowd out a good stand of rice, and the crop can not grow where the spike rush is well established. Good plowing, deep enough to get under the roots an turn them over, followed by thorough drying, is very effective in th control of this weed. The spike rush is not troublesome on lan which is reasonably well drained and properly cultivated. Its presence in rice fields often indicates poor seed-bed preparation, poo cultural methods, or poor drainage.

SPRANGLE-TOP.

Sprangle-top (*Leptochloa fascicularis*), locally known as ray-gras grows well on low land. It has entered the rice fields and is spreading quite rapidly. This grass grows about 2 or 3 feet high, stool heavily, and the fine stems terminate in a panicle. Sprangle-top matures seed from June 20 to October 1. The seeds are very small an are seldom, if ever, found in threshed rice.

Sprangle-top after it emerges will stretch through water mor quickly than rice, but it apparently does not germinate readily unde water. The seeds germinate as soon as mature, while water-gras seeds do not. The ripe seeds of sprangle-top fall to the water, germ nate, and the plants die before they mature seed. Cultivation afte germination will aid in controlling sprangle-top, and there is goo evidence that under early continuous submergence it may disappea

UMBRELLA PLANTS.

Three species of umbrella plants (Cyperus), commonly known a sedges, grow in the rice fields. The perennial forms grow on th levees and ditch banks and on poorly drained abandoned land. Thes forms are not troublesome on well-drained land properly cultivate On poorly prepared seed beds the perennial forms enter the check but improved drainage and good cultivation will rid the fields o them.

The annual form is found most abundantly in the rick checks. does not make its appearance until after the rice has been submerge Where stands are thin, and sometimes in good stands, it then appea in abundance. The plants grow from 6 to 18 inches high, and thick stand of them checks the growth of rice. No method of contr is known for this form, for it appears on good and on poorly draine land, on good and poor seed beds, and in thick and thin stands, bu it is usually thickest where the stands of rice are thin.

RED-STEM.

Red-stem (*Ammannia coccinea*) is found in shallow draina ditches, along sloughs, and in rice fields. This plant is increasin in the rice fields, especially where stands are thin. The plant co sists of a single stalk, with the flowers borne at the axils of t leaves. When mature the entire plant above ground is red in colo hence the name. The seeds are produced in a round capsule abo the size of a small pea. These capsules are often present in t threshed rice and, if green, may interfere with curing in the sac The base of the stem is covered with a spongelike structure. Goo cultivation will no doubt control red-stem.

RED RICE.

Red rice (*Oryza rufipogon*) is usually present in all rice-producing countries of the world. It is the worst weed in the rice fields of the Southern States and has been introduced into California with seed rice. It is not yet common, however, in that State. The infestations should be located and the plants hand-pulled and destroyed. Red rice can be detected in seed rice by hulling a sample of the grain. Red rice has a red seed coat when the hull is removed, while the common rice has a brownish or white seed coat. Seed containing red rice should not be sown. The presence of a few red grains in milled rice reduces its value.

Red rice has a spreading habit of growth, while our commercial rices grow more erect. The heads of red rice are loose, open, and slightly drooping. The grain shatters readily when ripe, and in this way it spreads very rapidly. The rice growers of California should guard against the spread of this troublesome weed pest. Seed rice bought outside the State should be examined carefully for red rice before it is sown.

A red rice, locally known as Italian, which is quite different in growth habit and size of kernel from the red rice just described, is now found in California rice fields. It matures earlier and has a longer grain than the ordinary red rice. Its growth resembles that of the commercial varieties of rice, but the seed shatters more readily. This red rice, like the other, lowers the commercial value of the crop, and seed rice containing it should not be sown.

CANARY GRASS.

Canary grass (*Phalaris paradoxa* and *P. brachystachys*), commonly known as California timothy, germinates during the late-winter and early-spring months and by the time the land is dry enough to cultivate has often made a luxuriant growth. Unless this growth is destroyed in preparing the seed bed it often checks the growth of the rice crop. Soon after the land is submerged canary grass dies, for it is not a water plant. This grass is readily controlled by good seed-bed preparation.

CRABGRASS.

Crabgrass (*Digitaria sanguinalis*) is often present on the field levees, but it seldom enters the rice checks. This grass has a spreading habit of growth and roots from the joints, or nodes, of the stem. It is practically impossible to pull this grass, owing to its method of rooting, but good cultivation tends to destroy it.

SLENDER ASTER.

Slender aster (*Aster exilis*), locally known as ironweed, grows quite thickly on rice-stubble land during the summer months when it is uncropped and not cultivated. When rice is sown on disked rice stubble, there is usually considerable slender aster in the rice crop, but this weed is easily controlled by good cultivation. Its presence in a rice field usually indicates that the crop was sown on a poorly prepared seed bed.

CHEAT.

Cheat (*Bromus secalinus*) is not a troublesome weed in the rice fields, but often is present in rice grown on poorly prepared seed beds on which the vegetation has not been killed. Because of the difficulty of removing cheat from rough or milled rice, the value of the crop is reduced. Wheat and barley are also objectionable in rough rice. Such growth therefore should be killed before the rice is sown, to avoid a reduction in the price received for the crop.

DISEASES, INSECTS, AND OTHER PESTS.

The California rice-growing sections have not been seriously troubled with either rice diseases or insect pests. Leaf-miners (*Hydrellia scapularis* Loew) damaged some rice at the Biggs Rice Field Station in the spring of 1922 while the leaves were lying prostrate on the surface of the water. The injury occurred on plats submerged continuously from seeding time in an effort to control water grass. The miners shredded the leaves of plants which had not yet assumed an erect position and in conjunction with the deep water killed the plants. Plants which were erect were not damaged.

Blackbirds are troublesome in rice fields in the spring and fall. In the spring large flocks of blackbirds pick up the rice, after broadcasting and before it is irrigated. The writer shot a number of blackbirds in the spring of 1922 and found that their crops contained from 4 to 48 kernels of rice. They no doubt consume considerable rice and may help to cause thin stands. They also damage the rice after heading, when it is in the milk stage. Keeping the blackbirds away by shooting early in the morning and in the evening when they usually feed will be found helpful.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

November 27, 1923.

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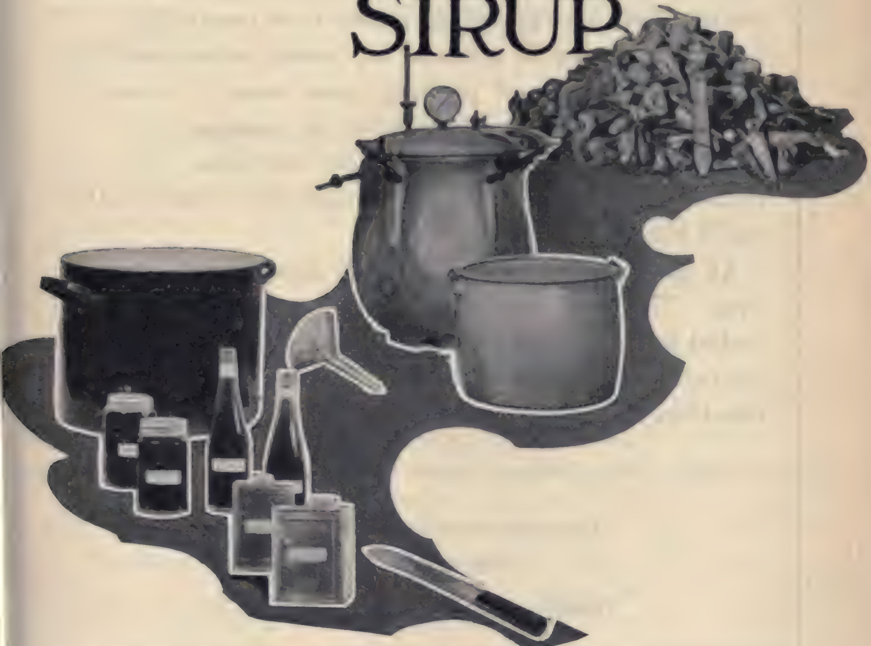
FARMERS' BULLETIN 1241
UNITED STATES DEPARTMENT OF AGRICULTURE

AN IMPROVED METHOD of MAKING SUGAR-BEET SIRUP



THIS BULLETIN tells how to grow sugar beets in the garden and describes a simple process of making from them a palatable and nutritious table sirup with a pleasant flavor. A patent for the process of making the sirup has been issued for the benefit of the public, so that anyone is free to use it. Tests have proved the process to be practicable.

Sugar beets may be grown in any locality which has tillable soil that is capable of producing good crops of vegetables. A small piece of ground is sufficient for planting a few rows of beets—enough to furnish the family with sirup. The tools needed are necessary in any garden operation—a spade, a hoe, and a rake.

All mature sugar beets, if properly handled, will produce a sirup. The beets are cleaned, peeled, cut into thin slices, and soaked in hot water to extract the sugar. The liquid is then treated and boiled down to the thickness desired. Detailed directions are given in the following pages.

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief
Washington, D. C.   November, 1921

AN IMPROVED METHOD OF MAKING SUGAR-BEET SIRUP.[1]

C. O. TOWNSEND, *Pathologist in Charge*, and SIDNEY F. SHERWOOD, *Chemist, Office of Sugar-Plant Investigations.*

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GROWING SUGAR BEETS FOR SIRUP.

THE PRODUCTION OF BEET SIRUP involves two distinct operations, (1) the growing of the beets and (2) the making of the sirup.[2] The sirup making embraces two essential operations, the extraction of the juice from the roots and the boiling down of this juice to the desired consistency.

THE EQUIPMENT NECESSARY.

Sugar beets may be grown and sirup produced in any locality which has tillable soil capable of producing good crops of vegetables. Therefore, anyone having a small piece of fertile tillable ground and the usual garden implements, a spade, a hoe, and a rake, is equipped to grow the beets necessary for the production of a home supply of sirup. In some localities the beets produced are richer in sugar than they are in other localities, but all mature sugar beets, if properly handled, are capable of producing sirup. The richer the roots are in sugar, the larger the quantity of sirup that may be produced from a given quantity of roots and the less the time that will be required to reduce the juice to the desired consistency.

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[1] This bulletin supersedes Farmers' Bulletin 823, entitled "Sugar-Beet Sirup," by C. O. Townsend, Pathologist in Charge of the Office of Sugar-Plant Investigations, Bureau of Plant Industry, and H. C. Gore, Chemist in Charge of the Fruit and Vegetable Utilization Laboratory, Bureau of Chemistry.

[2] A Government patent for the process of making sirup from sugar beets (patent No. 1155806, Oct. 5, 915) was issued to the authors of Farmers' Bulletin 823, H. C. Gore and C. O. Townsend, U. S. Department of Agriculture. Another patent (No. 1370372, Mar. 1, 1921), covering the improved process decribed in this bulletin, has been issued to Sidney F. Sherwood. The use of the processes covered by ither of these patents is free to any citizen of the United States.

SELECTING THE LAND.

The ground selected for growing the beets should be well drained and fairly fertile. Extremely poor, shallow, sandy, or hard soil should not be used for beets until it has been put in proper condition for crop production; likewise, ground that has been very heavily manured should be avoided, since such soil sometimes produces very large roots, poor in sugar. A few rows of sugar beets in the garden will generally be sufficient for a supply of sirup for home use. From 100 pounds of roots 5 to 8 pints of sirup can be produced. Beet roots when mature should weigh from 1 to 2 pounds each, and about 60 good-sized beets will weigh 100 pounds. These facts will enable one to estimate the area that will be needed to produce the home supply of sirup.

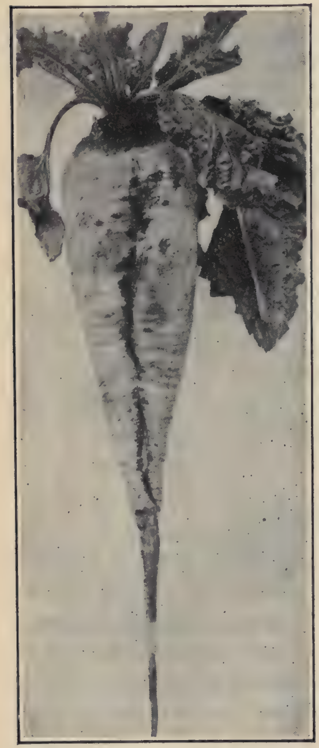
FIG. 1.—A beet root of good shape.

If more beets are grown than are necessary for the sirup supply, they will be found excellent for the table. When partly grown the entire plant may be used as greens, and when mature the roots may be cooked and served like garden beets. All sugar beets are white, and when properly grown they are generally much richer in sugar than the garden beet and just as tender. Sugar beets, either raw or cooked, are excellent feed for chickens, hogs, and other live stock.

PREPARING THE SEED BED.

The ground selected for growing the beets should be plowed or spaded to a good depth, remembering, however, that too much subsoil should not be brought to the surface at one time. The reason for a deep root bed for sugar beets is apparent from the shape and length of the root, as shown in figure 1. The ground should be plowed or spaded in the fall, but good results may be obtained by doing this work in the spring, provided the ground previously has been in good tilth. As early in the spring as conditions will permit, the ground should be harrowed or raked until it is firm, smooth, and free from lumps. The surface soil should not be too fine, especially in those sections where high winds are expected during the early summer. The ground should be kept free from weeds, but should never be worked when too wet. The proper time, always, for working the ground is when it is friable; that is, when it falls apart readily when handled.

PLANTING THE SEED.

Sugar-beet seed usually may be obtained, at least in small quantities, from the large seed dealers. A pound of seed will plant one-tenth of an acre if the work is done carefully. Usually a few ounces of beet seed will produce a quantity of beets sufficient for sirup making and for table use for the average family. The seed should not be planted until the ground is warm and the other conditions right for quick germination and for the subsequent growth of the plants.

Sugar-beet seed should be planted in rows about 20 inches apart and may be dropped either in continuous rows or in hills. If planted in hills each hill should contain from three to six seed balls, and the hills should be about 10 inches apart; if planted in solid rows the plants should be blocked in the manner described below as soon as possible after they are up. The seed should be covered to a depth of one-half inch to 1 inch. The covering should be as shallow as conditions will permit; that is, it should not be so thin that it will dry out and leave the seed without sufficient moisture for germination and it should not be so thick that the young plants can not readily get through to the light.

In growing sugar beets commercially the seed usually is planted with a 4-row drill designed especially for the purpose. In planting small lots of beet seed for sirup making, a garden planter of any of the usual makes, as shown in figure 2, will be found satisfactory. These planters can be set so that they will plant seed either in solid rows or in hills. In case a planter is not available, an area sufficient for sirup production can be planted easily by hand. In this case a shallow furrow may be made with a rake handle or other convenient implement and the seed dropped by hand and covered by using the back of the rake.

CARING FOR THE PLANTS.

If the seed is planted in solid or continuous rows the plants should be blocked. Blocking consists in cutting out a part of the plants with a hoe or other implement, so that the remaining beets stand in tufts about 10 inches apart. In blocking the beets, the direction of the stroke should be at right angles to the row, as shown in figure 3.

As soon as the plants are large enough to be handled conveniently, they should be thinned to one plant in each hill or tuft. This work must be done by hand, since the plants in the hills or tufts stand very close together. The plants should be cultivated and hoed from time to time, to keep down all weeds and to furnish the best possible conditions for growth.

If the natural water supply is not sufficient, the beets should be irrigated when they show signs of needing moisture. If the beets wilt during the day and fail to recover at night, they should be watered. In case of irrigating, a furrow should be made several inches from the beet row and the water allowed to run down this furrow until the ground is thoroughly wet. In no case should the surface of the ground around the beets be flooded, since flooding often causes a crust to form around the beet, cutting off the air supply from the root and thereby retarding the growth of the plant. From one to three irrigations will be sufficient in most of the sections where irrigation is necessary.

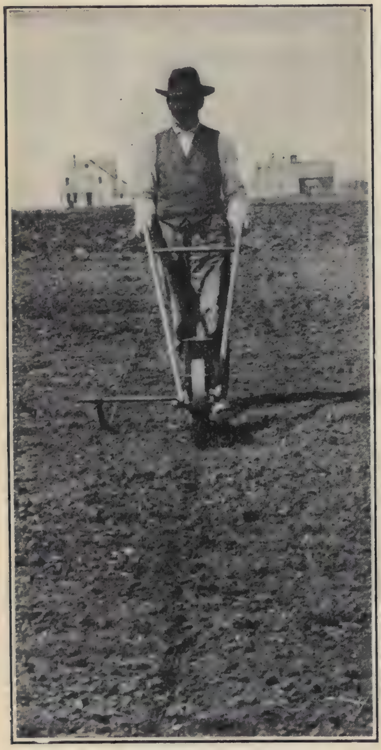

FIG. 2.—A garden seed planter.

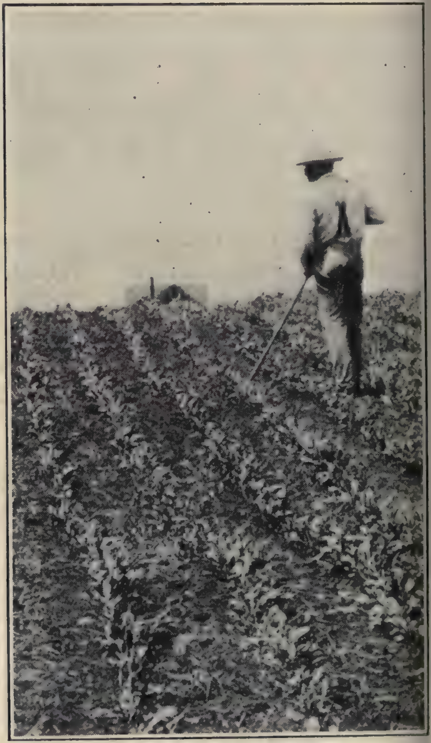

FIG. 3.—Blocking sugar beets.

HARVESTING THE ROOTS.

In most sections of the country from four to six months are required for the beets to reach their proper size and development. The proper stage of development for harvesting will be indicated by a yellowish tinge of the foliage and by the fact that the beets when pulled leave the ground almost free from dirt, as shown in figure 4. In no case should the beet roots be used for sirup making until they are mature. If the patch of beets is large the roots should be loosened by means of a so-called lifter, of which there are two kinds, the double-pointed and the side lifter. The latter is similar in appearance to a subsoil plow and is operated alongside the beet row, loosening the beets without breaking them. The plants then can be pulled and thrown into piles or rows. If the patch of beets is small and a lifter is not at hand, the beets may be loosened by means of a spade or a spading fork and thrown into piles. The beets should then be topped by cutting them off squarely at the point where the lowest leaf was attached. The topping can best be done by means of a heavy knife; usually a single stroke is sufficient to top a beet. The roots can then be made into sirup at once, or they may be stored until a more convenient time.

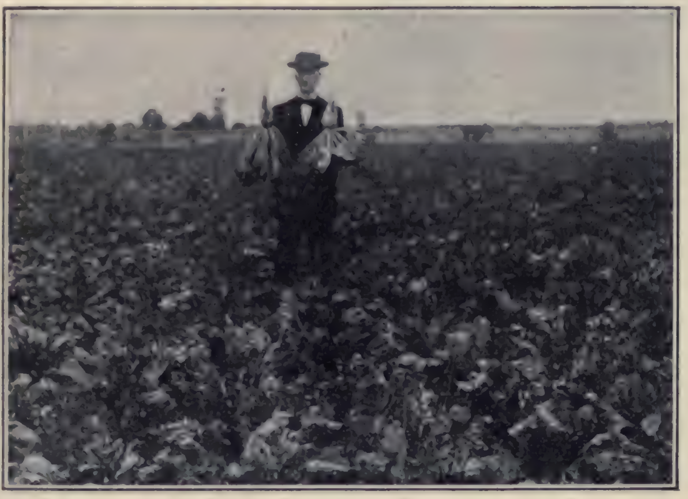

FIG. 4.—Field sugar beets, the kind to be grown in the garden for sirup making.

STORING THE ROOTS.

The roots may be stored either on the surface of the ground or in a pit or a cool cellar and kept for several months. The simplest and least expensive method of storing the roots is to throw them into a pile on the surface of the ground, in a well-drained spot. Dirt should then be thrown over the pile until it is almost or completely covered. If the weather is mild the top of the pile should be covered very lightly or left entirely open for a few days, until the roots have passed the heating stage. As the weather gets colder more dirt should be added, to prevent the roots from freezing and to keep them from wilting.

If the roots are to be pitted a hole or pit is dug in a well-drained place, the size of the hole depending upon the quantity of roots to be stored. The roots should then be placed in the hole and the surface covered with dirt, lightly at first, and the covering increased as the weather gets colder. If the beets are stored in a cellar they should be packed in moist sand or covered with sand or dirt to keep them from wilting.

The two points to be kept in mind in storing beet roots are (1) to keep the roots cool without letting them freeze and (2) to keep them from wilting. They will work up much better if they are kept fresh and crisp, although the wilting does not materially change their quality.

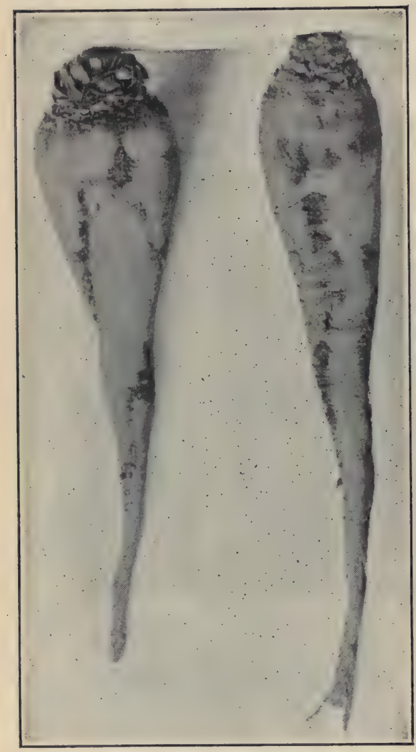

FIG. 5.—Beet roots for seed. Roots saved for seed should have the leaves removed without injuring the crown.

SUGAR-BEET SEED.

Those who wish to make beet sirup from year to year, especially in the cooler portions of the United States, may grow their own seed if they desire. Just how long seed can be thus produced without serious reduction in the quality of the roots has yet to be determined, but the indications are that at least several generations of beet plants may be produced without reducing the quality of the roots too low for sirup making. Two growing seasons usually are required for the production of sugar-beet seed from seedling plants. It is necessary, therefore, that the beets produced the first season be gathered in the fall and stored in the manner described above. In case the beets are to be used for seed production they should not be topped, but the leaves should be removed either by twisting them off or by cutting them off with a sharp knife without removing or injuring any part of the crown, as shown in figure 5. In this condition the beets should be stored until spring. They should then be planted in a well-prepared root bed just as early as weather and soil conditions will permit. The early planting of the roots seems to be an important requirement in beet-seed production.

The planting may be done by thrusting a long spade into the earth; the spade should then be pushed forward, the root crowded down back of the spade, as shown in figure 6, and the spade withdrawn. The dirt should then be packed around the root, the crown of which should be flush with or slightly below the surface of the soil, so that the crown is covered with a thin layer of dirt. A light covering over the crown seems to be of advantage in preventing it from drying out, and it also is a protection against late frost. The roots should be well supplied with moisture during the entire growing season, irrigating them if necessary, especially when the seed is forming. When the seed is ripe it may be gathered by pulling it from the seed stalks by hand. The habit of growth of the seed stalk, shown in figure 7, makes the gathering of the seed an easy matter. It should be spread in a suitable place to dry, after which it is ready for the next year's planting. No artificial heat should be used in drying the seed. Each plant produces from a few ounces to a pound of seed; hence, a very few roots will be sufficient to furnish the ordinary family with an abundant supply of seed for home use.

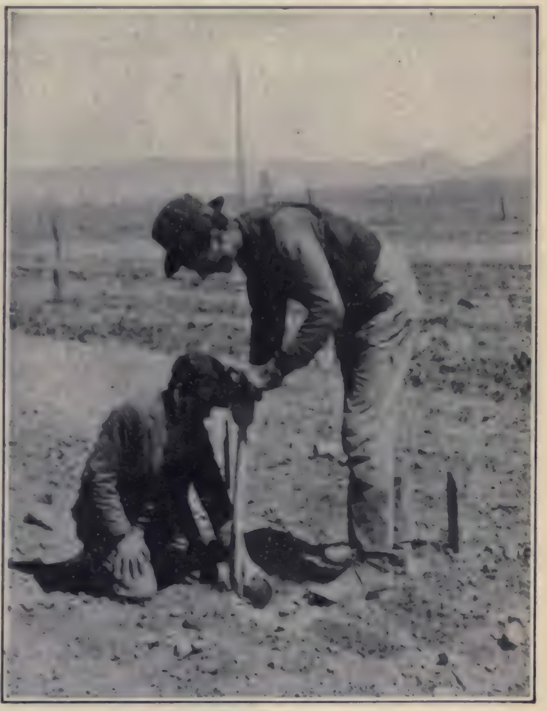

FIG. 6.—Planting beet roots for seed.

MAKING SIRUP FROM SUGAR BEETS.

PREPARING THE ROOTS.

The first step in making beet sirup consists in cleaning the roots and removing the top portion. The roots from which the tops have been removed at the time of harvest, as described on page 7, are soaked in water for a few minutes, in order to loosen the dirt, and are scrubbed thoroughly, preferably with a brush having stiff bristles, in a tub of clean water or under a stream of clean water. Cool water should be used for soaking and washing, as it restores the crispness of the roots that may possibly have become slightly wilted; roots that have been stored for some time and have become wilted to the point of softness should not be used for making sirup.

The crown or top portion of the cleaned beets should be cut off squarely at the line between the green and white portions. If this line extends to a considerable point below the lowest leaf scars, the cut may be made at the line of the lowest leaf scars and the green portions then removed by trimming. The reason for this further topping is that the crown contains the greater part of the salts taken from the soil in the process of growth, and it is desirable to have the sirup as free as possible from these mineral salts, because if

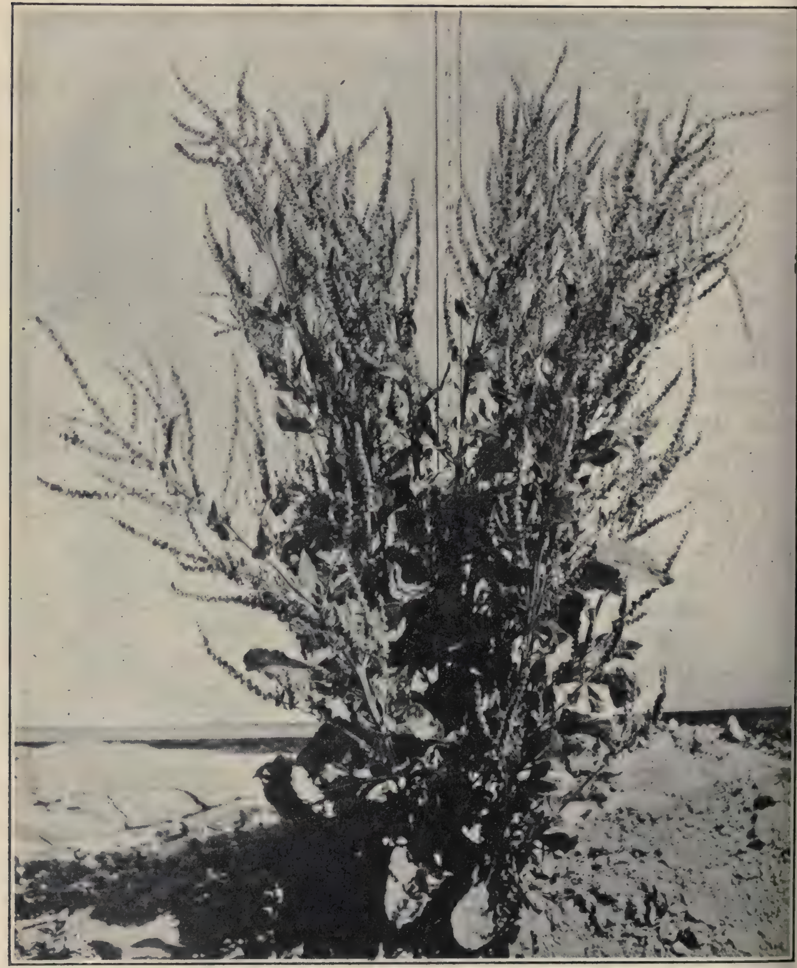

FIG. 7.—A common type of beet seed stalks.

present in too large quantities they may impart an unpleasant taste. Coloring matter and other materials in the green portions cause a darker colored sirup and tend to impart an unpleasant taste and flavor. This is true also of the skin or peel, which should be removed. The most satisfactory way to remove the peel is to slice it off with a large-bladed knife.

EXTRACTING THE JUICE.

To extract the juice containing the sugar, the peeled beets are sliced and the slices permitted to fall directly into hot water of sufficient depth to cover them and prevent access of air. Exposure of the peeled or sliced beets to the air results in the rapid darkening of the surfaces, which, if permitted to take place to any extent, causes a dark color in the sirup and tends to impart an unpleasant flavor. The slices should not be thicker than one-sixteenth of an inch and preferably much thinner, because the thinner the slices the more rapidly and thoroughly the juice will be extracted. A large-bladed butcher knife will be found satisfactory for slicing where a comparatively small quantity of beets is to be handled. An ordinary kraut cutter (fig. 8) or some type of vegetable-slicing machine (fig. 9) is more suitable for handling large quantities.

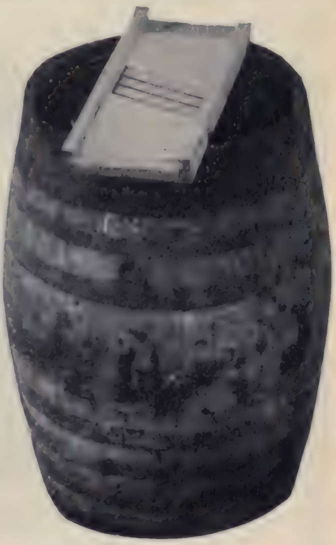

FIG. 8.—Barrel with upper head removed and kraut cutter securely fixed in place.

The slices should be permitted to soak for about an hour at a temperature of 174° to 180° F. (78° to 82° C.). An excess of water should be avoided, because it increases the amount of evaporation—and consequently time, labor, and heat—required to reduce the extract to sirup. The proper quantity of water is just sufficient to cover the slices and keep the air from them during the time of extraction, and hot water may be added from time to time as the quantity of slices in the container increases. The top slices may be held under the surface of the water by means of a plate or small wooden rack. A 10-gallon container will hold the slices from 100 pounds of original (untopped and unpeeled) beets and afford room for stirring them occasionally during the extraction.

The extracting should be done in clean vessels made of tin, enamel ware, aluminum, or crockery, or in a wooden container, such as a barrel. If a barrel or other wooden container is used, special care must be taken to have it perfectly clean. If a barrel is used it will be advantageous to have a faucet at the bottom to draw off the liquid. Copper or iron vessels should not be used either for the extracting or for the subsequent evaporating to sirup, as copper may give an unpleasant taste and iron a very dark color to the sirup. In case a barrel is used for the extracting, the water should be placed in it at a temperature of just about boiling. The addition of the slices will reduce the temperature sufficiently close to 174° to 180° F., and if the top of the barrel is then covered with heavy cloth the temperature will remain high enough during the hour's standing to afford a good extraction. Other containers may cool at a somewhat greater rate, and it may be found advisable to maintain the proper temperature by applying heat; in this case, a thin wooden rack should be placed upon the bottom of the vessel, to avoid scorching the bottom slices. After an hour the liquid is drained off and strained through cheesecloth or muslin. It is not necessary to press the residual slices. This refuse is a good feeding material for chickens, hogs, and cattle. The extract should be of a pale yellow color and slightly opaque. A single extraction does not remove all the sugar from the slices, but the greater part is removed where the slices are sufficiently

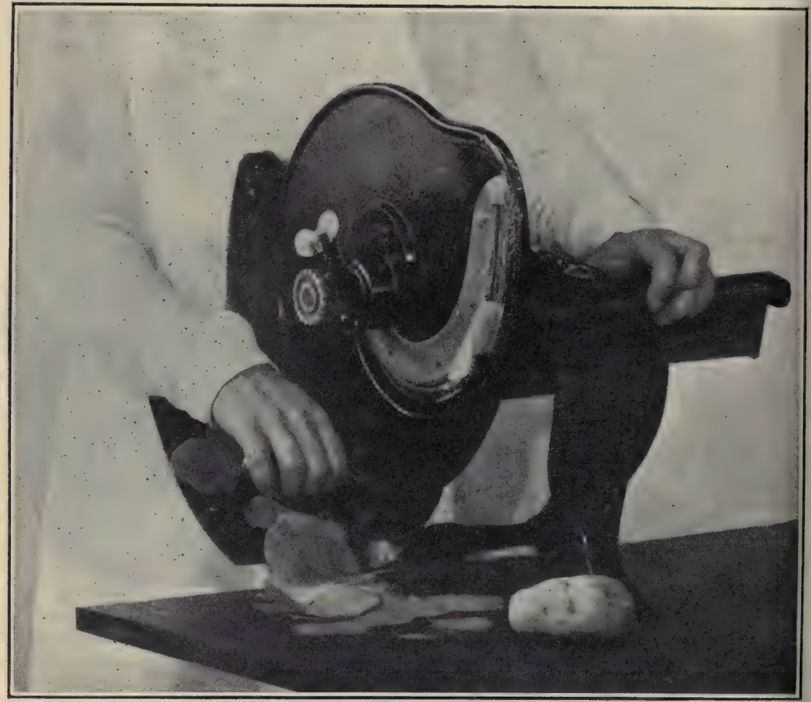

FIG. 9.—One type of vegetable slicing machine.

thin, and the quantity of sirup that may be obtained from a second extraction is not sufficient to warrant the time and labor involved in its extraction and subsequent evaporation.

HEATING THE EXTRACT.

The extracted juice, or a similar extract prepared in any other manner, is heated under pressure in a container which may be sealed and is provided with a controlled valve for blowing off steam, a thermometer, and a pressure gauge. Pressure cookers, such as are used in many homes in the canning of vegetables, etc., have been found very satisfactory for this purpose; an illustration of one type of pressure cooker may be found on the title-page of this bulletin.

The cover having been fastened down, the extract is heated to a temperature of 226° to 230° F. (108° to 110° C.)—corresponding to a pressure of approximately 21 pounds to the square inch—and maintained at this temperature for an hour, blowing off a considerable quantity of steam at approximately 15-minute intervals. When heat is first applied, the valve is left open, to permit the escape of air, and it is closed as soon as steam begins to appear. At the end of the heating the steam is permitted to blow off rapidly, and the extract, which should be of a pale yellow color and entirely clear, is strained through cheesecloth or muslin, to remove the slight quantity of coagulated material, and is then ready to be evaporated to sirup. Ordinarily this treatment removes the objectionable "beety" odor and flavor from the extract and consequently from the sirup. This process is recommended, though the time and temperature are not necessarily confined to those mentioned; thus, very successful results have been obtained by heating to 230° to 233° F. (110° to 112° C.) for one-half hour with the constant blowing off of a slight quantity of steam.

EVAPORATING TO SIRUP.

The extract is placed in a kettle made of tin, aluminum, or enamel ware and evaporated to sirup by boiling briskly. A shallow, flat pan is more satisfactory, as it permits the extract to be reduced to sirup in a shorter time through more rapid evaporation and results in a lighter colored sirup. For the reason stated in connection with the extraction, vessels of copper or iron should not be used for treating the extract or for evaporating it to sirup. The slight quantity of scum that collects on the surface during the evaporation should be constantly removed. Skimmers made especially for skimming sirup may be purchased, but a square piece of tin perforated with many fine holes, turned up to a height of about one-half inch along two of its edges and fastened to a wooden handle, will be found satisfactory. Great care must be taken toward the end of the evaporation to avoid burning or scorching the sirup.

If it is desired to do so, the heating of the extract under pressure may be omitted and the extract boiled directly to sirup. Sirup produced by this process will be palatable, but it will be inferior to sirup produced from pressure-heated extract, because it will retain to a greater or less extent an unpleasant flavor and taste which are eliminated by heating. Further, it will usually be cloudy or opaque to a greater extent, and it may be darker in color.

In connection with the production of other sirup, such as sorghum sirup and cane sirup, the juice is sometimes clarified by adding lime or other chemicals or by treatment with infusorial earth. Such processes are not satisfactory when the sirup is produced upon a small scale, and it is strongly recommended that no attempts be made to use them in the production of beet sirup upon a small scale, as they will result in sirup of an extremely inferior quality. Such processes can be applied satisfactorily only where the sirup is produced upon a large scale and under chemical control.

The sirup may be evaporated to any thickness desired, but a sirup containing 70 per cent total solids is suggested as suitable for table use. As a liquid thickens, the boiling point is raised; a thermometer, therefore, affords a satisfactory means of determining when the sirup has reached a density of 70 per cent solids. Water at ordinary pressure or at sea level boils at 212° F. (100° C.). In testing a sirup for its density in this manner, it is advisable to test the accuracy of the thermometer by placing it in boiling water and noting the boiling point registered. The sirup is then evaporated until the thermometer registers 12 degrees higher than this point (in the case of the centigrade thermometer 6.5 degrees higher). Altitude affects the boiling point of liquids. For every 500 feet above sea level, roughly speaking, the boiling point is lowered 1° F., so that water at a point 2,000 feet above sea level would boil at 208° F. and a finished sirup at 220° F. In taking the temperature one must be careful not to permit the bulb of the thermometer to touch the bottom or sides of the evaporating vessel or to be exposed above the surface of the sirup; otherwise, an incorrect reading will be obtained.

STORING THE SIRUP.

The sirup should be stored in bottles, jars, or cans that have been cleaned and then thoroughly sterilized with boiling water or with steam. The sirup should be placed in the containers while boiling hot and the containers sealed at once in an air-tight manner. Otherwise, the sirup may possibly become inoculated with the microorganisms that produce fermentation and molding, and "souring" or molding may take place.

YIELD OF SIRUP.

The yield of sirup obtained from the slices from 100 pounds of beets varies from 5 to 8 pints. The quantity of débris—crowns, green portion, and peel—varies from 40 to 50 per cent, and consequently the quantity of slices from 100 pounds varies from 50 to 60 pounds. The variation in the yield of sirup depends upon the variation in the percentage of sugar in the beets, which ordinarily runs from 12 to 20 per cent, also upon the quantity of débris, and the losses in handling the extracts and in skimming the sirup.

CHARACTER OF THE SIRUP.

Sirups made at different times by the process here described were of a light to dark-amber color and were free from the unpleasant odor and flavor which have frequently been found in sirups produced by direct evaporation of the extract, without the preliminary heating under pressure, and which have usually been found in sirups made from untrimmed and unpeeled beets. Many of the sirups were clear, others somewhat cloudy, the average cloudiness being no greater than in average cane or sorghum sirup. Sirups such as cane, sorghum, and maple, possess characteristic flavors, and the aftertaste of any one of them may be disagreeable to a person who is accustomed to any other. Beet sirup has a flavor quite distinct from any other sirup, the first taste being agreeable and very sweet, while the aftertaste is faintly similar to that of hoarhound, and expressions of opinions from numerous persons indicate that, as in the case of other sirups, it is agreeable to some people and not agreeable to others.

The average of the total solids in a number of sirups boiled to 223.7° F. (106.5° C.) was 70.29 per cent. The average percentage of sucrose was 63.20 and of invert sugar 2.73; or, combining the two, the average percentage of total sugar in the sirup was 65.93. Sucrose is the same as the ordinary granulated sugar sold in grocery stores. Invert sugar, which is produced from sucrose through certain changes that take place, differs in its chemical characteristics from sucrose but possesses practically equal food value.

Beet sirup is very likely to crystallize or "sugar out," especially when stored in a cold place, the crystals of sugar usually being large and having the appearance of rock-candy crystals. The sirupy part may be drained off and used in the ordinary manner, while the sugar may be used for sweetening. Care should be taken when using it, because it dissolves more slowly than ordinary granulated sugar. In the case of a sirup containing sucrose and invert sugar, the tendency to crystallize decreases as the proportion of invert sugar increases, and when the correct proportion of invert sugar and sucrose has been obtained the sirup will not crystallize. At present, processes for controlling the proportions of invert sugar and sucrose are entirely unsuitable for use in the home or on a small scale, as, when used, they necessitate careful use of special reagents.

USES OF BEET SIRUP.

The principal use of beet sirup is as a table sirup, but it may be used for all purposes for which other sirups are used, as in making candy and in making dark-colored cake and sweet bread. It may also be used in place of part of the sugar used in making jams. A pint of beet sirup containing 70 per cent of total solids will contain very nearly 14½ ounces of sugar, and thus, when substituting sirup for sugar, it will be necessary to add slightly more than 1 pint for each pound of sugar. A pint of sirup will also contain almost one-half pint of water, and when it is used in making cake or bread less water than usual should be added. When it is used in making jams, longer boiling will be necessary, in order to evaporate this added water.

The process as here described is intended primarily for the production of beet sirup on a small scale, as in the home. It is not improbable, however, that at some time beet sirup may be produced profitably on a factory scale—utilizing the by-products as cattle-feeding material—especially in certain sections of the West admirably suited for the production of beets, but situated far from a beet-sugar factory and where the available agricultural land is insufficient to support a sugar factory.

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1921

FARMERS' BULLETIN 1242
UNITED STATES DEPARTMENT OF AGRICULTURE

PERMANENT RUIT & VEGETABLE GARDENS

THE GROWING of small fruits and permanent vegetables in home gardens provides a greater variety of food. About 90 out of every 100 farms in the United States have upon them some form of a home garden or source of supply of fresh vegetables. Many of these gardens include, in addition to the annual vegetables, small fruits and certain of the perennial or more or less permanent vegetables.

Thousands of city, town, and village gardens also include small fruits, asparagus, rhubarb, and other permanent crops.

This bulletin gives brief instructions for the planting and care of the more important small fruits and perennial vegetables. More complete information may be found in the special bulletins of the United States Department of Agriculture and of the State Agricultural Colleges and Experiment Stations.

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief

Washington, D. C. Issued December, 1921

PERMANENT FRUIT AND VEGETABLE GARDENS.

W. R. BEATTIE, *Extension Horticulturist*, and C. P. CLOSE, *Extension Pomologist*, *Office of Horticultural and Pomological Investigations*.

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PERENNIAL GARDEN CROPS.

A HOME GARDEN is incomplete unless it includes some of the more permanent vegetables and small fruits in addition to the regular annual vegetables that are usually planted. A bed of asparagus, several hills of rhubarb, a few plants of horse-radish, strawberries, raspberries, blackberries, dewberries, Logan blackberries, grapes, currants, and gooseberries, according to locality and available space, are valuable additions to the home garden. All of the above might not thrive in any one locality or on one type of soil, and care must be exercised in making the selection.

The products of the small fruits and the permanent vegetables of the garden are many and add very greatly to the variety of food. Rhubarb pie and sauce have just the right tartness and flavor that one craves during the first days of spring. Later on, when strawberries are plentiful, a little of the rhubarb canned with the strawberries adds the most delicious flavor and tartness to the berries. Currants are considered one of the most desirable fruits for jelly making, and when thoroughly ripened they make an excellent sauce and dessert, especially if mixed with raspberries. Jellies, jams, and marmalades in plenty can be made from raspberries, dewberries, and blackberries, to say nothing of the juices and various products that may be made from grapes. By having a collection of the different small fruits that are adapted to the region one can enjoy a continuous supply of good things to eat throughout the greater part of the summer and in addition have an abundance of preserves for winter use.

There should be a great revival in the planting of small fruits and grapes in connection with home gardens, especially in sections where home orchards are dying out or new ones are not being planted. The care of small fruits as regards spraying and other requirements is more simple than that of the orchard fruits, and the small fruits can be grown on a much more limited space.

When space is available a section of the garden may be set aside for the permanent vegetables and the small fruits. The location of these permanent crops, however, should be such that they will not interfere with the plowing of the garden or the cultivation of the annual vegetables. In no case should the small fruits be crowded, it being best to plant a limited number, selecting those best adapted to the region. In small gardens the asparagus bed may be placed in one corner or in an offset at the end of the garden, and the hills of rhubarb along the side fence, where they will be out of the way of general cultivation. Sometimes the rhubarb or asparagus is arranged in a sort of row or narrow bed across the front of the garden, separating the garden proper from the lawn at the rear of the house. In large gardens everything should be planted in straight rows in order to facilitate cultivation. Blackberries and dewberries can often be trained upon a fence, and grapes can be grown on an arbor over the garden walk.

Climatic and soil conditions restrict the planting of some of the vegetables and a number of the small fruits to prescribed localities. For example, rhubarb thrives only in those parts of the country where the ground freezes to a depth of 4 inches or more during the winter.

Generally speaking, raspberries will not stand very hot or dry weather. Blackberries can endure hot weather, but not hot drying winds. Dewberries are grown mostly in the warmer parts of the country. In very cold sections the plants of these fruits should receive some kind of winter protection. Logan blackberries are grown mainly in the Pacific Coast States. Currants and gooseberries do best in a cool climate, but can stand quite warm summers if they have plenty of water. It is not permissible to plant currants and gooseberries in sections where the white pine is grown, because these plants harbor the blister rust, which is destructive to white-pine trees. There are varieties of grapes for every section where any other fruits are grown. Strawberries will grow practically everywhere.

PERENNIAL VEGETABLES.

ASPARAGUS.

Plenty of asparagus for a family of six persons can be grown on a plat of ground no larger than 12 or 16 feet square, provided the soil is well enriched and the plants are given good attention.

Success with asparagus depends largely upon the proper preparation and planting of the bed and upon keeping the soil in which the plants are grown in a high state of fertility by frequent applications of fertilizer or manure. In view of the fact that asparagus plants are long lived, producing for many years, the bed should be located where it will interfere as little as possible with other garden operations. Asparagus requires a type of cultivation different from that given the regular vegetables, in that only the surface of the ground and the space between the plants can be worked.

Asparagus roots go deep into the soil for their supply of plant food and moisture, and for that reason the plants should be set only upon land that is broken and enriched to a depth of at least 18 inches. Before setting the plants the upper 10 or 12 inches of soil should be dug out of the trench and then about 3 inches of well-rotted manure spaded into the lower strata of soil to a further depth of 6 or 8 inches. The trenches should be 3 feet apart and the surface soil piled in ridges between the trenches. Then, after the plants are set and slightly covered, the remainder of the surface soil should be worked in around the plants as they grow. It matters very little as to the kind of manure, so it is reasonably free from straw or other coarse material; however, a partially rotted mixture of cow and horse manure will generally give the best results. Bone meal, at the rate of 1 pound to 4 yards of trench, should be mixed with the upper 8 inches of soil.

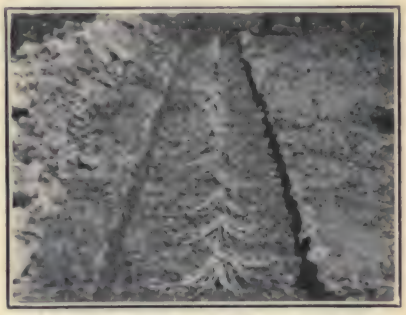

FIG. 1.—Asparagus crowns or plants being set in a trench.

Asparagus plants are started from seed; but one or two years are required to grow the plants, and it is usually best to purchase strong 1-year-old plants from some nurseryman. The plants or crowns are set during the late autumn or early spring, while they are in a dormant condition. They should be set 18 inches apart in the trenches. The crown of the plant should be 4 to 5 inches below the surface and the roots well spread out, as shown in figure 1, and fine soil worked in between them. The plants should be "checked;" i. e., set in straight lines in both directions, so that they may be easily cultivated. Do not allow the plants to dry out before setting them.

No shoots should be cut from the plants before the third spring after setting the bed, and even then cutting should continue for only a short period. After the third year the bed may be cut for the full season of five or six weeks. The bed should reach its maximum production about the seventh year and, if properly cared for, continue in prime condition for 8 or 9 years. Cases are known where asparagus beds have been in use for more than 30 years and still gave excellent results.

VARIETIES.

There are four or five varieties of asparagus in general use, the Palmetto, Conover's Colossal, and Argenteuil being among those most planted in the past. Recently two new varieties, known as Washington and Martha Washington, both of extreme vigor and disease resistance, have been introduced. Much depends upon getting good, strong plants, and it pays to obtain a larger number than is actually needed and then discard all the weaker ones.

CULTIVATION.

The asparagus bed should be given clean cultivation from the very start and a vigorous growth encouraged. After the bed has reached its third year and the cutting of the young shoots has begun, the bed should be kept free from weeds by hand weeding until the end of the cutting period, then given a thorough renovating with the hoe and the shoots allowed to develop tops. A top-dressing of about 2 inches of rotted manure and a very little commercial fertilizer should be given at the close of the cutting period. It should be borne in mind that during the summer the plants store food in their roots with which to produce the spring crop of succulent shoots, and it is essential that they have plenty of plant food to build upon. Weeds and grass may be smothered during the latter part of the season by mulching the bed with coarse manure.

Late in the summer or early autumn, when the asparagus tops begin to turn yellow and die, the tops can be cut off just above the ground and removed. This will give an opportunity for thoroughly renovating the bed and getting rid of all weeds or grass and will check rust. In the South, Bermuda grass is very difficult to control if it ever gets started in the asparagus bed.

INSECTS.

The asparagus beetle may greatly injure the growth of the plants during the late spring and summer months. The eggs of this insect are laid in clusters on the young shoots, and these soon hatch into small dark-colored grubs that feed upon the tender growth. To destroy the grubs dust the plants while the dew is upon them with Paris green mixed with four or five times its volume of air-slaked lime. Another remedy is to spray the plants with a solution consisting of 10 level teaspoonfuls of the paste form of lead arsenate in 1 gallon of water. In preparing this spray care must be taken to mix the poison thoroughly with the water; also to apply it in the form of a fine spray, so that all parts of the plants will be covered.

USES OF ASPARAGUS.

The young, tender shoots of asparagus, as they spring from the crowns and appear at the surface during the early spring, are the parts used. (See fig. 2.) Shoots should be cut every day during the season of rapid growth, and none should be allowed to remain to develop tops, as a crown will stop producing new shoots as soon as tops have been allowed to grow on it.

Use a sharp chisel-shaped knife to cut the shoots below the surface. The shoots should be cut while crisp and tender, before the bud or tip begins to unfold. If it is desired to have blanched asparagus, 2 or 3 inches of loose soil may be heaped over the hills; then the shoots may be cut 4 or 5 inches below the surface just as soon as the tips break through.

One method of preparing asparagus for the table is first to peel the lower part of the shoots, then boil until tender in water to which a little salt has been added. Next drain and serve with drawn butter. Another method is to cut the asparagus into short lengths and boil until tender; then add cream and serve on toast.

Any surplus asparagus tips not wanted for immediate use may be canned.

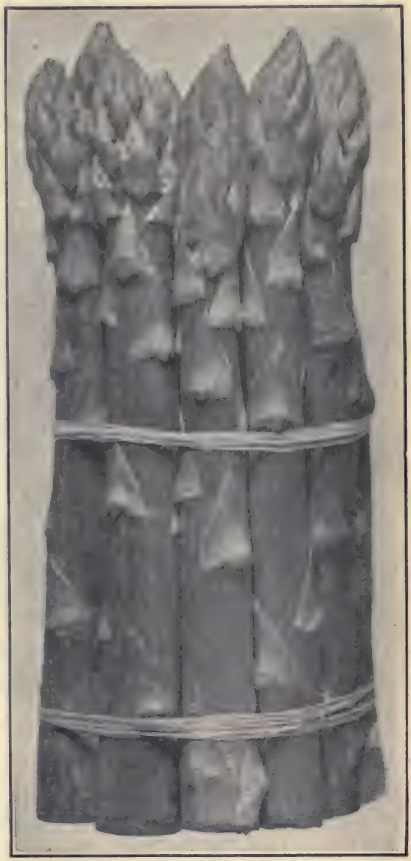

Fig. 2.—Washington asparagus in proper condition for use.

RHUBARB.

Rhubard, sometimes called pieplant, is not adapted to the Southern States, but only to that part of the country having a moderate rainfall and where the ground freezes to a depth of 4 inches or more during the winter. Everybody in the regions where it can be grown is familiar with rhubarb as it appears in bunches upon the markets during the spring. It is scarcely necessary to mention that the leaf stem is the part used and that the way to use it is in pies or, better, in the form of sauce. Rhubarb possesses fine dietetic qualities and acts as a natural spring tonic.

The same cultural directions given for asparagus will serve for rhubarb, except that only five or six hills (fig. 3) will be needed to supply the average family, and the hills should be spaced much farther apart than for asparagus. The variety known as Linnæus is most commonly grown. As a rule, a few hills of rhubarb are planted along the garden fence, where it will be out of the way.

The usual method of starting the plants is to obtain pieces of root from established hills and simply set them in soil that has been deeply spaded and heavily manured. The hills should be at least 4 feet apart and the roots set 3 or 4 inches below the surface. The hills should be fertilized each year, the same as for asparagus. No stems should be pulled from the hills until the second year, and comparatively few should be pulled before the third season. The hills of rhubarb should be divided and reset in about seven years, or they will become too thick and produce slender stems.

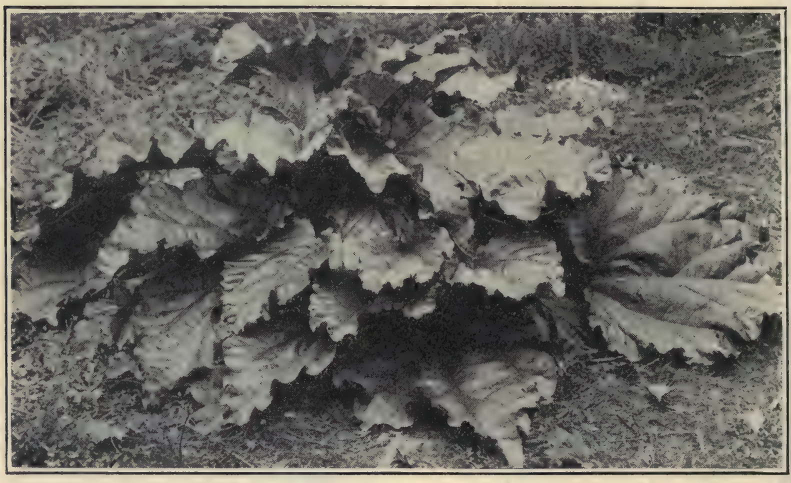

FIG. 3.—A good hill of rhubarb.

The stems of the rhubarb leaves are frequently stung by an insect; however, this does not often occur until after the spring season, and very little harm results. Rhubarb is also troubled with one or two diseases, but up to the present these have not interfered to any extent with the growing of rhubarb in the home garden.

HORSE-RADISH.

Grated horse-radish is a very desirable condiment during the winter months, and it is always best when fresh. A few hills of horse-radish (fig. 4) planted in an out-of-the-way place in the garden will supply the table. The plants are easily started from pieces of older roots about the size of a lead pencil, or a little larger, and 6 or 8 inches in length. When the horse-radish is dug in the autumn, the slender roots are removed, stored in a box of moist sand, and buried outdoors or kept in a cool cellar until spring. The large roots intended for use can be kept in the same manner. Before the root cuttings are planted, the ground should be spaded to a depth of about 12 inches and plenty of well-rotted manure or a little fertilizer worked into the soil. A trench 4 or 5 inches deep is opened with a hoe, and the root cuttings are placed at an angle, with their tops near the surface of the ground. Each root cutting will sprout in several places and form a number of tops. After these are well established, the soil should be carefully removed by hand from around the cuttings, and all but one good heart near the top of the cutting removed. The earth should then be replaced around the root and drawn up well about this remaining top to support it. If the ground is rich the roots will be ready for use the following autumn. As a rule the plants in the home garden are not reset each year, but simply allowed to grow in a great cluster and the roots removed as needed for use. This method, however, does not give as large or as tender roots as where the plants are set each year. Horse-radish is like asparagus in that it requires rich soil and plenty of moisture. It will not grow well on land that is poorly drained.

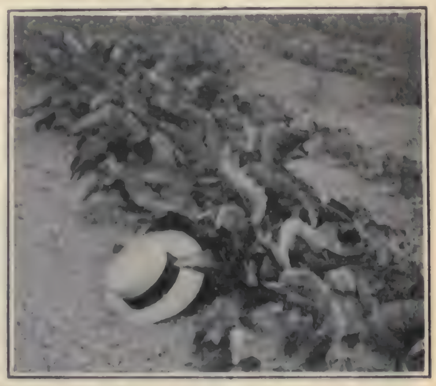
FIG. 4.—Horse-radish, first season from cuttings.

SMALL FRUITS.

RASPBERRIES.

There are three types of raspberries according to color of fruit, the red, the black, and the purple. The red type differs from the others in its habit of growth and in its method of forming new plants. The canes of the red type do not usually branch much, but the black and purple varieties branch considerably, especially if the tips are pinched out of the young shoots when they are 2½ to 3 feet high. (Fig. 5.)

The red type.—The red type is propagated by suckers, that is, new shoots coming from underground rootstocks. Each shoot and its attached piece of root make a new plant. Some good varieties are the Cuthbert, Loudon, Marlboro, and Ranere (*St. Regis*). The Ranere bears an early summer crop closely following strawberries, and if the new shoots are not cut back in the summer or fall it bears a late fall crop also.

The black and purple types.—The black and purple types are propagated by the tips of the branches touching the ground and forming roots. This is done in the late fall. To get a new plant, cut the rooted branch a few inches above the ground and dig out the rooted part. Among the good black varieties are the Cumberland, Gregg, Farmer (*Plum Farmer*), and Kansas.

For home use the purple varieties are very desirable, because the plants are extremely vigorous and productive and the fruits are large, juicy, and of good quality. The berries are dull purple and rather unattractive in color, and are not always popular on the market unless they are well known. There are five good varieties, Cardinal, Columbian, Haymaker, Royal, and Shaffer.

FIG. 5.—Raspberries grown in a home fruit garden.

PLANTING RASPBERRIES.

Trim the long roots back to about 6 inches and cut off the broken ends of short roots. Dig holes or plow furrows deep enough and wide enough to take in the roots without crowding, set the plants an inch or two deeper than they were before being dug, and fill in and tramp down the earth until the hole is filled. Cut the tops back to 1 inch or less to remove any stem disease present.

Set the plants 3 feet apart in the row and have the rows 6 to 8 feet apart.

PRUNING RASPBERRIES.

During the first year no pruning is necessary unless a very heavy growth is made, and then only the growing tips of the black and purple varieties will need to be cut or pinched off when they reach a height of 2 or 3 feet. These new canes of the first year ought to bear fruit the second year. Only the 1-year-old canes bear fruit, and since these die after producing one crop, they, and also all weak shoots, should be cut out as soon as possible after the crop is gathered so as to let all the strength of the plants go into growing strong new shoots for next year's fruiting. Cut the tips off the new shoots of the black and purple varieties when they are about 2 or 2½ feet high, and they will branch and become stocky. In the spring cut the side branches back to 10 or 12 inches and the tops to about 4 feet if they are taller than that, and take out all weak shoots. Leave from five to eight shoots to each plant. If the old canes were not taken out after fruiting, get them out early in the spring before growth begins.

The red varieties do not need as much pruning as the others. Cut out all fruiting canes after the crop is gathered, and if the new shoots grow 5 or 6 feet high cut back the tops to about 4 feet in the following spring before growth starts. If a great many new shoots come up, pull out all but those needed for the row.

TRAINING RASPBERRIES.

Either drive a stake by each plant and tie the shoots to it or build a wire trellis to support the shoots. The trellis may be made of one row of posts 3 feet high, with cross arms perhaps 2 feet long nailed to the tops and a No. 10 galvanized wire run lengthwise along each side of the row, fastened near each end of the cross arm, or by setting a row of posts the same height along each side of the row and fastening the wires to the tops of the posts.

CULTIVATING RASPBERRIES.

Apply a dressing of manure each spring if the ground is not rich enough to cause a vigorous growth, and give raspberries good cultivation throughout the season. After good cultivation for a year or two the ground may be permanently mulched with waste hay, straw, or vegetable rubbish to take the place of cultivating and weeding.

CLEANING UP OLD RASPBERRY PATCHES.

If the berry patch has been running wild, but is worth saving, cut out all the dead and weak canes and plow and cultivate the spaces between the rows. If the plants are thick in the row, dig out enough so those of the black and purple varieties left will be about 2 or 2½ feet apart with five to eight canes per plant. Plants of the red varieties may be left a foot or more apart in a kind of double row. Prune these, as mentioned in another paragraph, and build a wire trellis, if this seems necessary.

WINTER PROTECTION.

In very cold sections, especially where there are cold, dry winter winds, it is necessary to give all berry bushes some protection. This is best done by gently bending down the plants all one way lengthwise of the row and covering them with a few inches of earth. In large patches this may be done by plowing a furrow over the row from each side and then finishing the covering with a shovel if necessary. In the spring uncover the plants and straighten up the canes.

BLACKBERRIES.

New plants of blackberries grow as suckers from the roots just like red raspberries or from pieces of roots 3 to 4 inches long planted 2 or 3 inches deep in the spring. The planting, pruning, cultivating, mulching, trellising, winter protection, and general care of blackberries is the same in all respects as for black and purple raspberries. Set the plants 3 feet apart in rows 6 to 8 feet apart. Keep the suckers pulled or dug out and leave only five to eight of the strongest canes on each plant. Some good varieties are Mercereau, Agawam, Blowers, and Eldorado. (Fig. 6.)

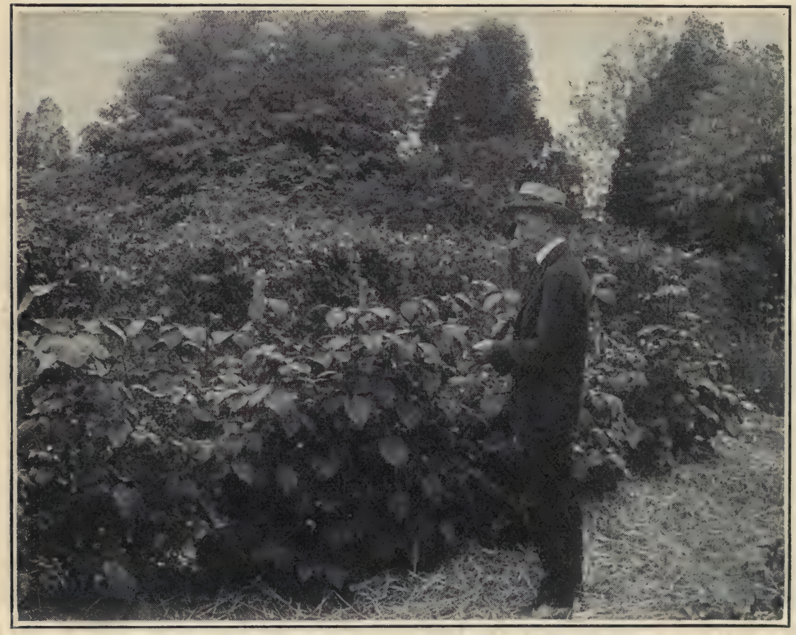

FIG. 6.—Blackberries the second season after planting.

LOGAN BLACKBERRIES (LOGANBERRIES).

The Logan blackberry is a trailing type which resembles the dewberry in its habits of growth and in forming new plants by the tips of the canes sending roots into the ground. It is a very strong grower, sometimes producing canes 20 feet or more long.

This berry should be planted only in the mild sections of the Pacific Coast States. It will not survive cold winters and does not seem able to adapt itself to conditions away from the Pacific coast.

For garden use, set the plants in the spring 6 feet apart in rows 6 or 8 feet apart. Let the new canes trail over the ground the first year. During the second spring, either drive a strong stake by each plant, wrap the canes around it and tie with soft twine in three places or build a trellis with two or three wires and tie the canes to the wires.

After the fruit is picked, cut out the old canes and tie up the new ones. If the new canes grow too long, cut them back to any desired length. Give the same general care required by blackberries.

DEWBERRIES.

Dewberries are similar to blackberries in most respects except that the canes creep along the ground and form new plants by rooting at the tips. Set the plants 3 feet apart in rows 5 or 6 feet apart, or 5 feet apart in rows 5 feet apart if cultivation is to be given both ways.

Set out the plants in early spring and give good cultivation throughout the season. Let the canes lie on the ground the first year. Drive a stake 5 or 6 feet long at each hill the next spring or build a 1 or 2 wire trellis to support the canes. If stakes are used, wrap the canes once or twice around them and tie in two or three places with soft twine. If a wire trellis is used, tie the canes along the wires.

Dewberries are pruned much like other berries. Cut out the old canes after fruiting and clip back the new growth if the canes grow longer than 5 or 6 feet. Leave about six canes on each plant. In the cold parts of the country the canes must be laid down and covered with earth, straw, or other material for winter protection. This protection is removed in the spring, and the canes are then tied to the stakes or wire trellis.

CURRANTS.

Do not try to grow currants in sections where the white pine flourishes, because a very destructive disease of this pine lives and thrives on these bushes.

PROPAGATION OF CURRANTS.

Currants are propagated by cuttings or by rooted shoots from well-established plants. Cuttings, 8 or 10 inches long, of well-ripened twigs are taken in the fall and planted up to the top bud in well-prepared soil, or they may be tied in bundles and kept slightly moist in sand in a cold place until spring and then planted.

VARIETIES OF CURRANTS.

Currants come in three colors—red, white, and black. The black ones have a rather strong characteristic flavor which many people do not like. The red fruit is most popular, although the white is just as good. Four good red varieties are Fay, Red Cross, Perfection, and Pomona. The White Grape is a good white variety and Champion (*Black Champion*) a good black variety.

PLANTING, PRUNING, AND CULTIVATING CURRANTS.

For home use a few bushes, such as the one shown in figure 7, are sufficient. Set the red and white varieties 4 or 5 feet apart and the black ones 6 to 8 feet apart. Very little pruning is needed until the shoots begin to crowd; then cut out the weak and oldest ones and cut back any long, straggling growths. Leave 8 or 10 strong shoots to each plant. Currants are usually planted along one side of the garden and are then neglected. They ought to be given good cultivation and manure or fertilizer, as mentioned for raspberries. They will endure shade if they must, but full sunlight is desirable.

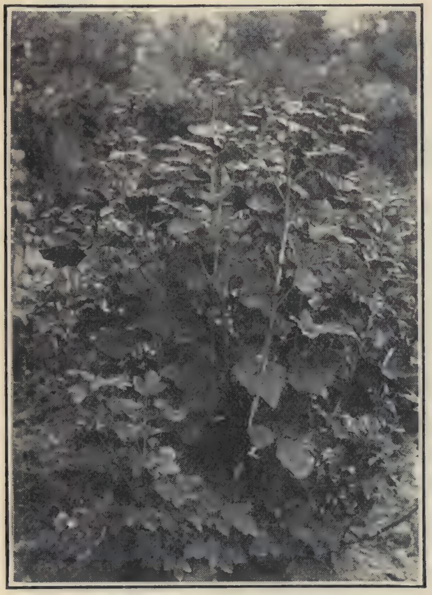

FIG. 7.—Currant plant, two years after setting.

GOOSEBERRIES.

Gooseberries are propagated by cuttings or rooted shoots, like currants, and also by mound layering, but they should not be planted in sections where the white pine flourishes, as they, like currants, are hosts to a very destructive disease of that tree. In mound layering the tops are cut off in the early spring, leaving stubs 4 or 5 inches long. Many new shoots will grow from these stubs, and when they are hardening a little in early summer cover the lower 4 or 5 inches of these shoots with a mound of earth. Each shoot will then send out roots, thus forming an independent plant. The earth is taken away in the fall and the young rooted plants cut off and either planted or kept slightly moist in earth or moss in a cool place until spring. Gooseberries need the same care and cultivation as currants, but should be planted 6 feet apart. The English varieties bear large to very large fruits, but they do not always succeed well, on account of mildew, so it is usually best to plant the smaller American varieties, such as Downing, Houghton, Josselyn, Poorman, and Van Fleet. The Industry is a good English variety.

STRAWBERRIES.

Strawberries are so easily handled and require so little room that if only one of the small fruits can be grown they should be the one selected. New plants may be purchased at small cost from a nurseryman, or perhaps may be obtained free from a neighbor.

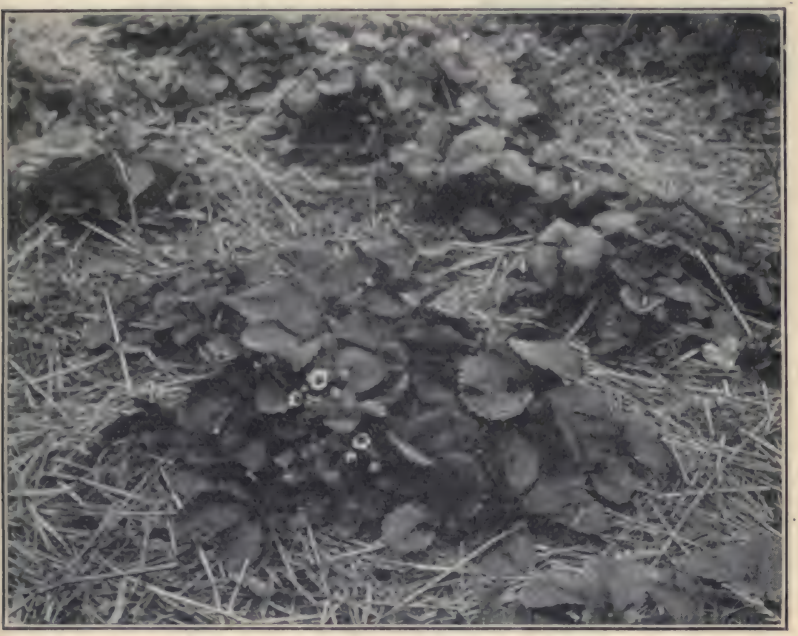

FIG. 8.—Hill of everbearing strawberries.

SYSTEMS OF CULTURE.

The strawberry plant may be grown in hills or in narrow or wide matted rows. For very small areas, plants set in hills close together, as shown in figure 8, will no doubt produce the most and largest fruit, but will require more care than matted rows. For hill growing, set the plants 1 foot apart in the row and have the rows just far enough apart to cultivate easily, say from 2 to 3 feet; or set two rows a foot apart in double rows and have a space of 2 or 3 feet between the double rows. Keep all runners cut off and give good cultivation, so as to make extra strong plants. Some of the choicest varieties for hill culture are the Marshall and Chesapeake of the single-crop kind and the Superb and Progressive of the everbearing varieties. The everbearing varieties will no doubt be most satisfactory for hill culture.

To start matted rows, set the plants 18 inches apart in rows from 3 to 4 feet apart. For a narrow matted row, as shown in figure 9, train the first runners along the row, covering about a foot in width, and cut off all later runners. From four to six new plants from each plant set will make a narrow row. For wide matted rows, save enough new plants to make the row 2 feet wide, or more, as desired. Do not let the plants crowd each other; have them 3 or 4 inches apart.

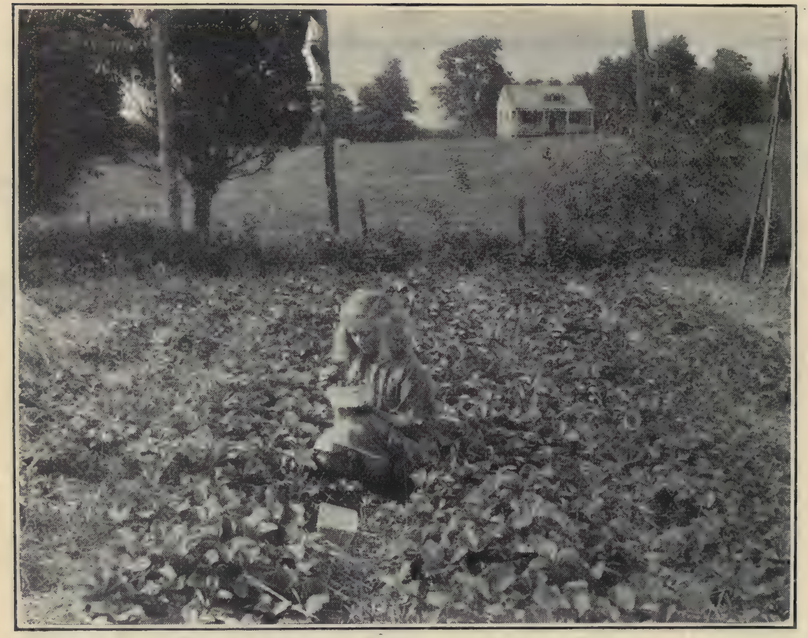

FIG. 9.—Strawberries growing in matted rows.

SETTING THE PLANTS.

Set the strawberry plants early in the spring, if possible, so they will get the benefit of spring rains and make a strong early growth. Trim off the dead leaves and all but one or two of the live ones and cut the roots to about 4 or 5 inches long. Spread the roots somewhat and set the plants just as deep in the soil as they were before they were dug. Be especially careful not to set them deeper and not to get earth over the growing crowns, for this will probably kill the plants.

The newly formed plants are sometimes set with success in summer or early fall if they are given special care and watering. If they can be taken up with balls of earth on their roots, transplanting ought to be successful. Young plants grown in pots may be transplanted with perfect success. To grow these potted plants, use 2-inch plant pots filled with soil well packed down, and sink a pot in the ground beneath each new runner plant, so it will send its roots into the soil in the pot. Transplant these to the garden whenever they are well rooted. To get a plant out of the pot, hold it upside down and tap one side of the rim gently on wood to loosen the earth from the pot and cause it to come out unbroken. Water the plants as soon as set and whenever necessary later.

CULTIVATING AND MULCHING.

Give newly set strawberries frequent cultivation and hoeing during the entire season to keep down the weeds and make strong plants for fruiting the next year. Pick off all blossom buds which appear except in the case of fall-bearing varieties, on which some blossoms may be left after August 1 to fruit in the fall. When the ground freezes cover the plants or the entire bed with about 2 inches of straw or other vegetable matter free from weed seeds. Coarse strawy manure, with the fine portions shaken out, is excellent for this purpose. The object of this winter covering is to keep the ground from freezing and thawing with each change in temperature, because this freezing and thawing will slowly lift the plants out of the ground. When growth starts, rake the covering off the plants and leave it between the rows.

In the spring when the plants begin to blossom spread nitrate of soda along each side of the row, using 1 pound to 80 feet of row. If the ground has not been mulched, cultivate and then mulch with vegetable matter between the rows, so as to conserve the moisture from the spring rains. Work the mulch around the plants, to protect the fruit from dirt.

CARE AFTER FRUITING.

If the bed is to be saved for another year, rake off the mulch as soon as the crop is gathered, and hoe or pull out the older plants, leaving only enough of the younger ones to send out runners to make a new narrow or wide matted row, as desired. If the leaves on the plants left are spotted with disease, cut or mow them off and burn them. A pound of nitrate of soda per square rod of ground scattered around the plants will start a vigorous growth. Put this on when the plants are dry, for it will injure any damp parts of the plants it touches. Handled in this way a bed may be kept for several years, because the new plants of one year are saved for fruiting the next.

Old beds may be cleaned up, as just mentioned, by hoeing or plowing the spaces between rows and leaving the youngest plants in the row.

VARIETIES OF STRAWBERRIES.

There are several varieties of strawberries which bear a spring crop and more or less of a late summer and fall crop. These are called everbearing or fall-bearing varieties and are very desirable for the home garden. To have a big fall crop, set the plants in the spring, cultivate well, and pick off all blossoms every few days until late July or August. These will bear fruit up to the time of quite heavy frosts and will bear again in the spring, after which they may be discarded. Set new plants of the everbearing varieties each spring for the fall crop of fruit, because these give better results than plants in the old bed. The Superb and Progressive are good fall-bearing varieties.

Of the single-crop varieties the Klondike is the one almost universally grown in the Southern States, where it covers a long season. In the Northern States the season of any one variety is rather short, so the home garden should contain an early, a medium, and a late fruiting variety. The following are among the good varieties and are arranged according to season: Premier, Early Jersey, Ozark, Dunlap, Bubach, Parsons, Marshall, Chesapeake, and Gandy. All these varieties, except the Bubach, have perfect blossoms.

PERFECT AND IMPERFECT BLOSSOMS.

Strawberry blossoms are of two kinds. One kind is called "perfect," "staminate," or "male," and the other kind "imperfect," "pistillate," or "female." Some varieties have perfect blossoms and other varieties have imperfect blossoms. Those with perfect blossoms produce pollen which will fertilize both perfect and imperfect blossoms and cause them to bear fruit. The varieties with imperfect blossoms can not set fruit without receiving pollen from perfect blossoms.

Do not plant varieties having imperfect blossoms without also planting at least one perfect-blossom variety to pollinate them. One row with perfect blossoms will pollinate four rows with imperfect blossoms.

The nurserymen's catalogues and State agricultural experiment station bulletins always specify whether a variety has perfect or imperfect blossoms.

GRAPES.

PROPAGATING VINES.

Grapes are usually propagated by cuttings of the last year's growth of canes; these are made in late fall or early spring and should be two or three buds long. Keep them in slightly moist sand in a cool place until they are planted. Dig a trench about 10 or 12 inches deep and set the cuttings 4 inches apart either straight or slanting in the trench and fill in and pack down the soil around them. Give good cultivation and water if necessary during the season. Dig these when 1 or 2 years old for planting in the garden. If plants must be bought, get those 2 years old, if possible.

PRUNING VINES BEFORE PLANTING.

Cut off all the top except one stub with two or three buds and trim the roots to about 4 or 5 inches long.

PLANTING THE VINES.

Set the vines 10 feet apart in the row, and if there are two or more rows, have them 10 feet apart to give room for cultivating and spraying. Dig the holes a foot or more deep and about 15 inches across. Hold the vine in position and fill in and pack the soil around the roots, setting the plant just as deep as it was before it was dug.

Grapevines may be planted along the garden fence and trained on the fence, if desired. They may be trained on supports along buildings, if placed where they will be shaded not more than a few hours each day. They may also be trained over the top of sheds, ash houses, or garages.

Currants, gooseberries, or strawberries may be grown between the rows of grapes, if desired. Strawberries may be grown in the row between the grapevines when the Munson system of training is used.

CULTIVATION.

Keep the ground well cultivated and all weeds killed. As soon as the soil is dry enough after heavy rains, stir it with a cultivator or hoe.

PRUNING YOUNG VINES.

During the first year, let the new canes trail over the ground at will. The canes which make a strong enough growth are to be saved, one cane to the plant, to form the trunk canes. Early the next spring cut the tops off the trunk canes, from 30 to 54 inches high, depending upon the system of training to be used. Also cut off the side branches, if there are any on these trunk canes. Drive a stake into the ground by each plant and tie the trunk cane to it. During the second year the fruiting arms will grow from the trunk cane.

If the plants make only a small growth the first year, cut off all the top except one stub of two or three buds the next spring; let the strongest bud grow into a trunk cane, and handle as mentioned in the paragraph above.

Decide upon the kind of trellis wanted and build it before the third year's growth begins.

PRUNING FRUITING VINES.

Prune fruiting vines in the late fall or early spring. There are two methods of pruning fruiting vines, the renewal and the spur systems. In renewal pruning all the previous year's growth is cut off except the two or four canes to be saved for the fruiting arms. In the two-arm system the best arm nearest the trunk on each side is left, and in the four-arm system two high and two low arms are left in the same way.

In spur pruning, the fruiting arms are left year after year, and the previous year's shoots on these arms are cut back to spurs of one or two buds. There may be either two or four arms, as in renewal pruning.

Either renewal or spur pruning may be done with the different systems of training. The renewal method has the advantage, in that no old wood except the trunk cane is left.

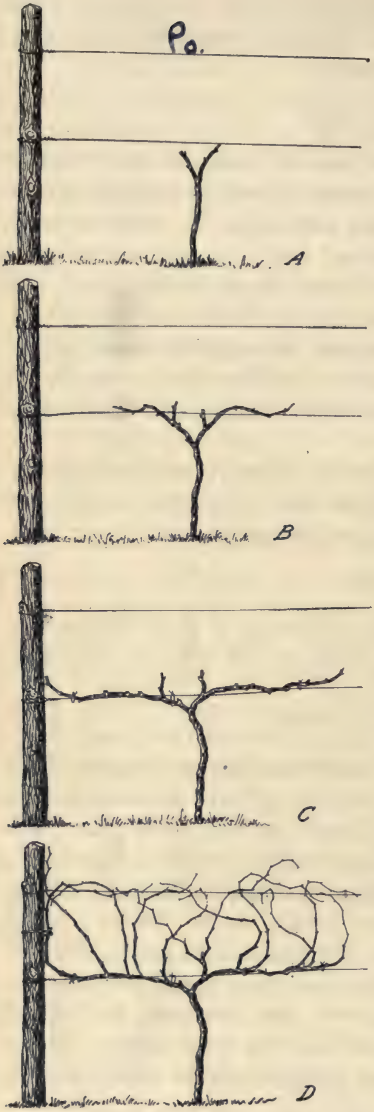

Fig. 10.—A pruned and unpruned vine at different ages, showing the method of pruning by the renewal system: *A*, Beginning of the second year; *B*, beginning of the third year; *C*, beginning of the fourth year; *D*, the same vine as above at the end of the fourth season's growth. At the beginning of the fifth and succeeding seasons it is cut back the same as *C* by cutting away old wood and renewing the growth by leaving new canes.

SYSTEMS OF TRAINING.

Of the many systems of training grapevines, only four of the best will be described here. Usually only two or four fruiting canes or arms are left to bear the crop of fruit.

High renewal system.—In the high renewal system two fruiting arms are allowed to grow low on the trunk cane, and they are tied to the lower wire (fig. 10). These arms are renewed each year by saving the best arm nearest the trunk on each side and cutting off the old arms and all other growth. The arms saved are cut back to 8 or 10 buds, and this renews the bearing wood every year. When the new shoots from the bearing arms are long enough, they are tied to the upper wire for support.

Horizontal-arm spur system.—The horizontal-arm spur system is like the one just described, except that the two fruiting arms are left year after year and the shoots on them are cut back every spring to spurs with one or two buds (fig. 10). The new shoots are tied to the upper wire for support.

Four-arm renewal system.—In the four-arm renewal system four fruiting arms are left, two on the lower and two on the upper wire. These are pruned and renewed exactly as described under the high renewal system above, but the new shoots are usually not tied; they grow naturally without support. This is a good system for strong-growing varieties.

Modified Munson system.—The modified Munson system is one of the best for both productiveness and ease of handling the vines. The trunk cane reaches to the wire about 54 inches above the ground and has two fruiting arms, one tied to the wire in each direction (fig. 11). As the new shoots grow they droop over the supporting wires at the ends of the crossbars. The fruit is easily and quickly sprayed and gathered when trained by this system.

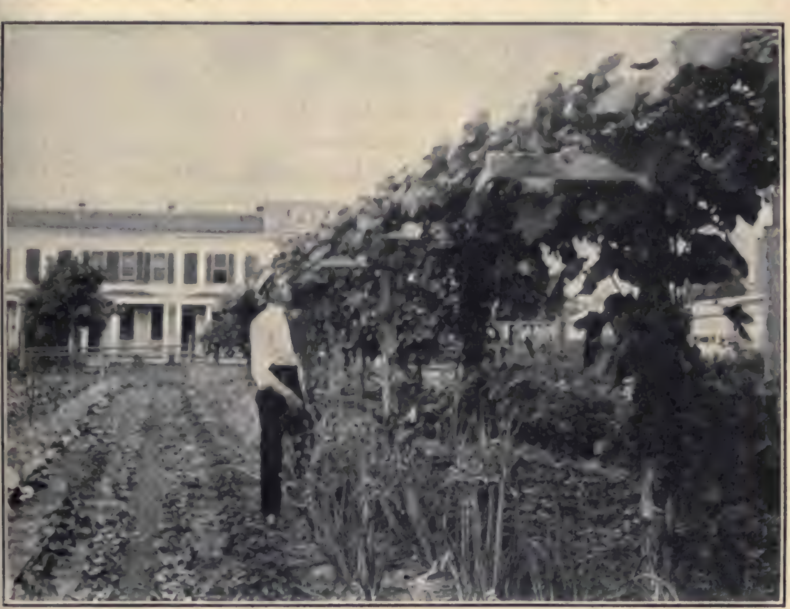

FIG. 11.—Grapevines trained by the modified Munson system.

THE GRAPE TRELLIS.

The ordinary trellis is built of No. 10 or 12 galvanized wires stapled to strong posts set securely 5 feet or more out of the ground and spaced 16 to 20 feet apart. If two wires are used, place them 30 and 56 inches above the ground. If three wires are used, place them 24, 40, and 56 inches above the ground.

The modified Munson system of training grapes is fine for home use. At the top of posts 5 feet high crossbars 2 feet long are nailed. Two wires extend lengthwise of the row, one being stapled on each side along the ends of the crossbars. The third wire is either stapled to the posts or run through holes bored through them 6 inches below the top of the posts. The fruiting arms are tied along this lower wire, and the new growing shoots droop gracefully over the other wires, which support them without any tying.

If the garden is large enough for it a grape arbor will be a pleasing addition to the permanent garden. Or it may lead from the house to the garden. The grape arbor is usually 8 feet or more wide and as long as desired. Strong posts 9 or 10 feet long are set securely 2 or 3 feet deep and 10 or 12 feet apart. Either wires or 1 by 2 inch wooden strips are nailed along the outside of each row of posts at 30, 48, and 66 inches above the ground. If the top of the trellis is to be flat, nail 2 by 4 wooden crosspieces to opposite posts and fasten wires or 1 by 2 inch wooden strips 15 inches apart lengthwise of the arbor. If the top is to be of even-span roof shape, nail 2 by 4 inch wooden plates on the top of each row of posts and fit rafters to these; fit them directly over the tops of the posts. Fasten wooden strips or wires 15 inches apart to the rafters lengthwise of the arbor. In a very large garden an arbor or a pavilion of summerhouse type may be made the central feature.

FARMERS' BULLETINS RELATING TO FRUITS AND VEGETABLES AVAILABLE FOR FREE DISTRIBUTION BY THE DEPARTMENT OF AGRICULTURE.

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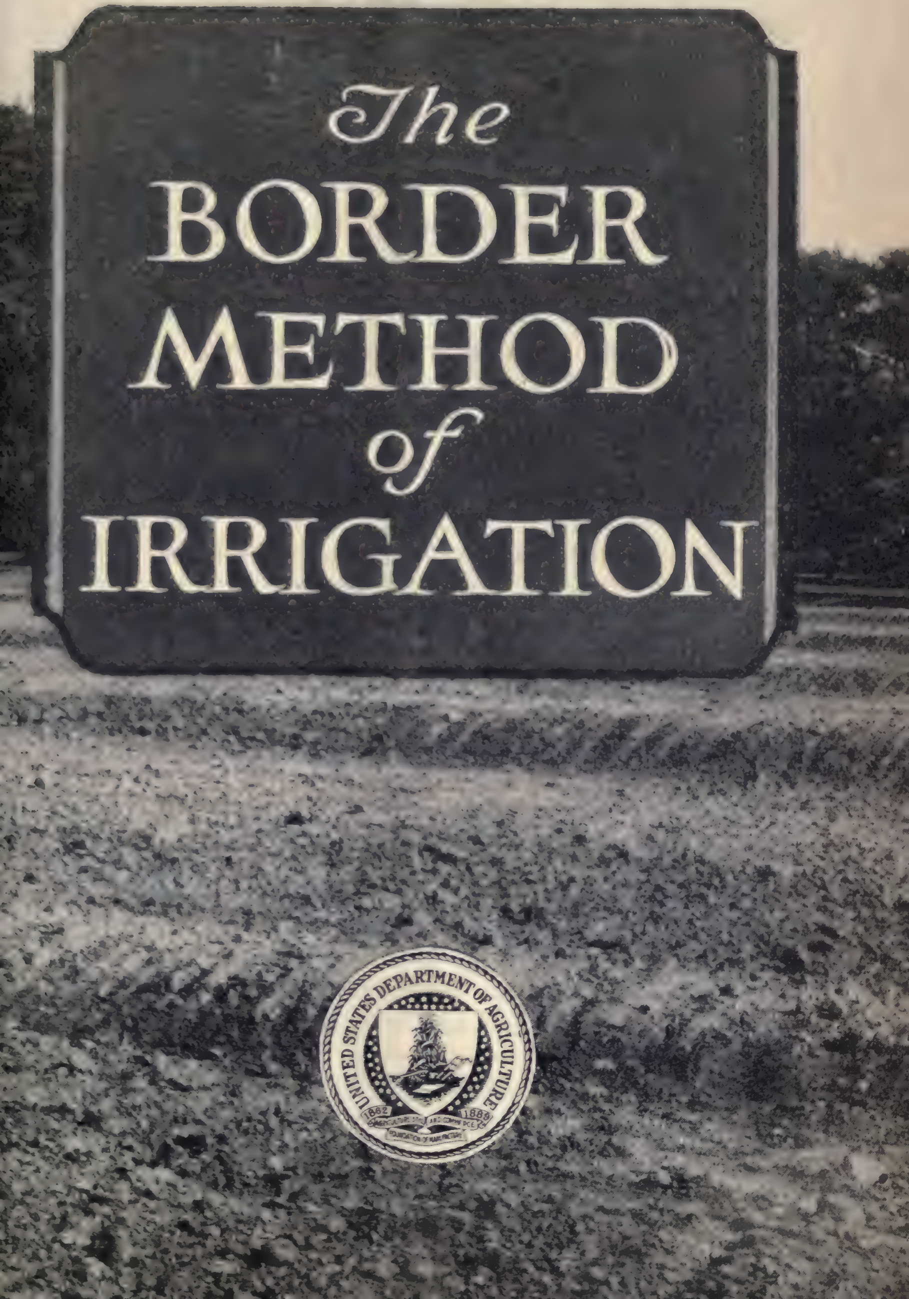

The BORDER METHOD of IRRIGATION

THE PRIMARY PURPOSE of irrigation is to maintain an adequate amount of moisture in the soil around the roots of plants, and this can only be done by an efficient method of application. Crop yields in irrigation farming depend for the most part on the uniform distribution at the right time of the proper amount of water to the soil. The border method of irrigation described in this bulletin, while but one of several methods followed in Western States, is well adapted to a variety of soils and crops and is growing rapidly in public favor.

Contribution from the Bureau of Public Roads
THOS. H. MacDONALD, Chief
Washington, D. C. February, 1922

THE BORDER METHOD OF IRRIGATION.[1]

SAMUEL FORTIER,

Associate Chief, Division of Agricultural Engineering.

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THE BORDER METHOD of irrigation consists essentially in the division of the field to be irrigated into a series of strips,[1] lands, or beds, as they are variously termed, by low, flat levees extending usually in the direction of the steepest slope. Sufficient water is then turned into the upper end of each strip and this water moves down the slope in a thin sheet, moistening the soil to a given depth as it advances toward the lower end.

ADAPTING METHODS TO LOCAL CONDITIONS.

Crops are irrigated in various ways. About a dozen methods of applying water in irrigation have been more or less generally used in this country. This diversity is due to the varied conditions and requirements found not only in widely separated localities, but also on farms of the same locality. In deciding upon a method of irrigation, it is necessary to consider the amount of seasonal rainfall, the slope and general character of the ground surface, the amount of the water supply and how it is delivered, the kind of crop to be grown and the likelihood of a rotation of crops, and the porosity or imperviousness of the soil and subsoil. To these are usually added questions pertaining to cost, economy, and the permanency of the work to be done.

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[1] In an effort to standardize terms, the word "strip" has been used in this publication.

Sometimes a single requirement will outweigh all others. This holds true in a measure in the irrigation of truck crops in the Atlantic Coast States and throughout the humid region generally, where the spray method of irrigation is the most common. By means of parallel lines of overhead pipes, in which small nozzles are inserted at regular intervals, it is possible to apply very small amounts of water during dry spells without incurring the risk of putting on too much prior to a heavy rain or of damaging the truck crops by running water between the rows. Similarly in the irrigation of rice in the Gulf States the contour check with its modifications may be said to be the standard method. In western practice certain crops, such as potatoes, sugar beets, and corn, are planted in rows and cultivated, and for such crops the furrow method is preferable. Except, however, in the few general cases cited, the farmer may choose among several ways of preparing land and applying water, and it is not always easy to make a wise selection. Few farmers possess the requisite knowledge to make a choice, and instead of calling in assistance, they merely imitate what their neighbors have done, though it may not be the best for their needs. So common is this latter practice that one frequently finds large areas, made up of farms which differ widely in their physical condition, all irrigated in the same way.

CONDITIONS THAT FAVOR THE BORDER METHOD.

A smooth, regular surface having a slope in one direction of about 2.5 inches to the hundred feet may be regarded as ideal for the border method of irrigation. It is possible to make borders on slopes 1 inch or less to the hundred feet and on steeper slopes up to 2 feet and more per hundred feet. Cases might be cited where borders have been used on slopes as great as 7½ feet to the hundred feet, but extra care must then be taken to prevent soil and crop erosion.

The amount of water which can be turned into the strip depends on the size of each strip, its slope, and other conditions. In narrow, short strips the head used may be reduced to half a cubic foot per second or from 20 to 25 miner's inches, and in wide, long strips 10 cubic feet per second may be none too large. A large volume of water can not be handled successfully on steep slopes, but it is always possible to divide a head between two or more compartments.

The kind of crop to be grown must usually be considered in connection with the rotation of crops. It seldom pays to prepare a field for the border method for one crop. Since this method is well adapted to the irrigation of alfalfa, clover, and other forage crops and also of all grains, the forage crops may be rotated with the grains without modifying the method. It is also possible to irrigate potatoes, sugar beets, and other rowed and cultivated crops by making a slight change in the borders, so that the latitude as regards rotation is rather wide.

The most favorable soil for borders is a free-working loam several feet deep, underlain by a more or less impervious subsoil. As the sheet of water flows down each strip, the pervious top soil is readily moistened and the tighter soil beneath prevents the waste of water by deep percolation. Borders are also very generally used where the subsoil as well as the top layer of soil is porous, not because such formations are the most favorable but because no other method will do as well.

The cost of preparing land for the border method is low as compared with that required for most other methods if the physical conditions are favorable. Besides, it is usually feasible to obtain a fair crop at small cost by the use of temporary borders, and after the crop is harvested, the making of permanent borders may be undertaken without undoing much of the previous season's work.

PREPARATION OF PERMANENT BORDERS.

The chief preliminary operations in the border method consist in making the necessary surveys and in laying out the borders in accordance with the requirements of the farm and the physical conditions. Closely related to these preliminary steps are the location of supply ditches or pipes and the main laterals, and the determination of their capacity. These in turn bring up the subject of water supply, its delivery in rotation periods, and the various structures, such as gates, checks, siphons, and drops, required for its proper control. Then follow the building of border levees, the preparation of the ground surface between borders, and the disposal of any waste water which may occur. These features will be considered in the order given.

SURVEYS.

In the subdivision of large areas of land such as townships, the customary practice of having square units containing 640 acres and 160 acres respectively possesses advantages over irregular surveys. On the other hand a rigid adherence to square and rectangular tracts n laying out a farm for irrigation frequently places a handicap on the undertaking during its formative stage which no future modifications can well rectify. The reason for this is that for such farms he water supply is of first importance and the shape and boundaries of the farm should conform to the water channels as well as to the configuration of the land surface, quality of soil, and other coniderations.

The State Land Settlement Board of California has adopted with satisfactory results the logical plan of subdividing land for State colonies in conformity to the topography. In the plat of the Durham colony located in the Sacramento Valley of California, an outline of which is shown in figure 1, the original land lines were seldom used as farm boundaries, but new ones were established more in accordance with the canal system, the character of the soil, and the productivity and value of the land. Where the soil is fertile and deep, the holdings are relatively small and were sold to settlers at $200 to $225 an acre; on heavier and less desirable soil the price ran from $75 to $180 per acre in larger lots, and some of the shallow land, fit only for grazing, was sold in still larger lots for as low as $10 per acre.

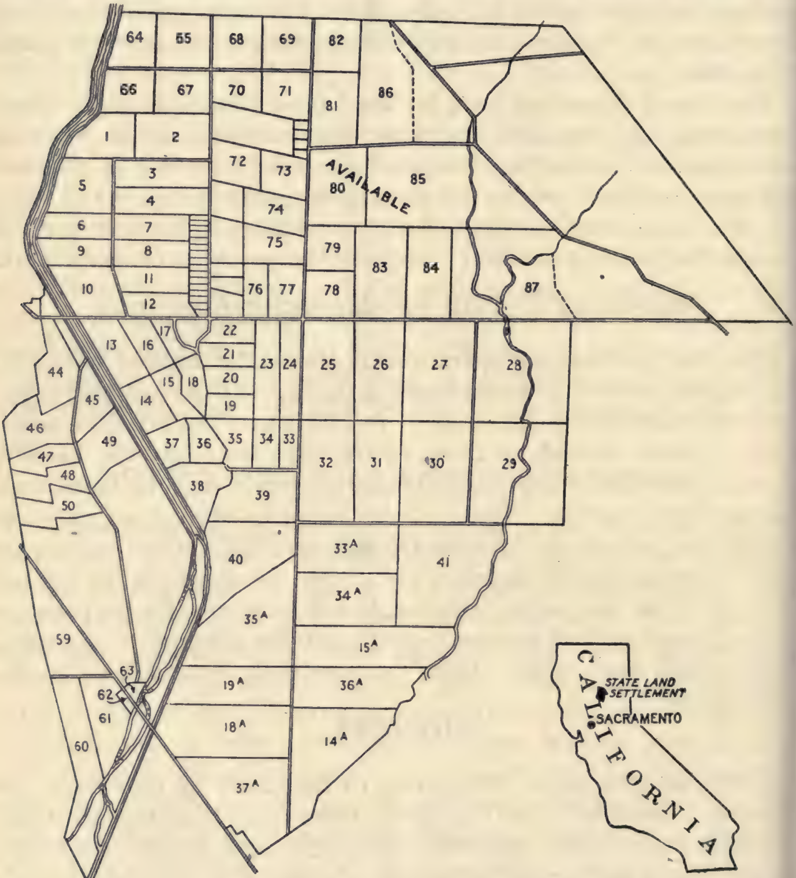

FIG. 1.—Outline of farm lots, and laborer's allotments on the Durham Land Settlement Colony at Durham.

Figure 2 is an enlarged sketch of farm lot No. 74 of the Durham colony, showing 6-inch contours and two natural ravines. Figure 3 shows the same lot, together with the size and direction of the borders and the necessary supply ditches and drains.

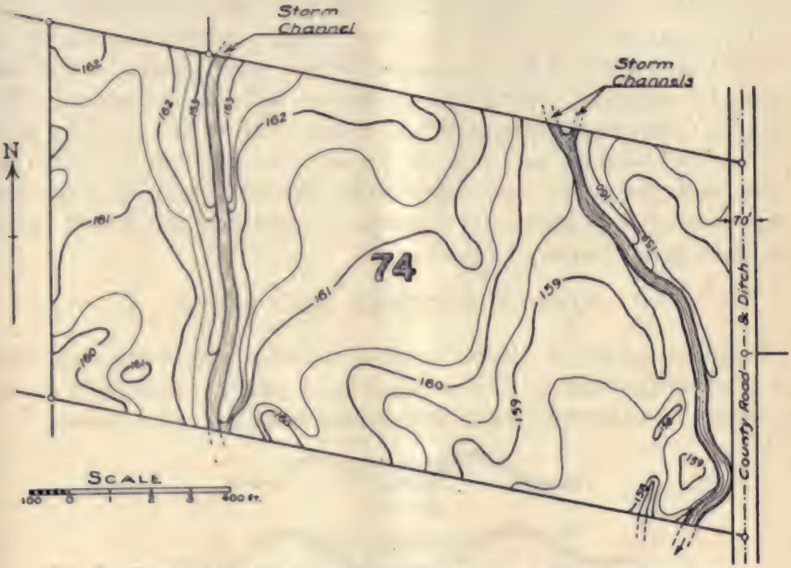

FIG. 2.—Farm lot No. 74 enlarged, showing contours of the Durham colony.

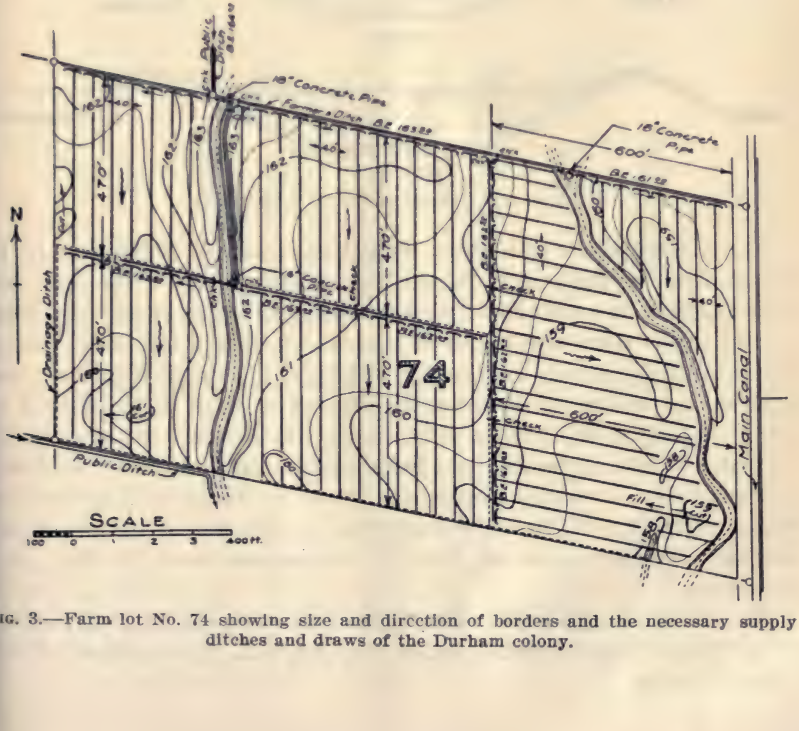

FIG. 3.—Farm lot No. 74 showing size and direction of borders and the necessary supply ditches and draws of the Durham colony.

In laying out farm systems of irrigation for any method of water application, contour surveys should first be made, especially if the surface is at all uneven or irregular. Such contours can readily be located and mapped by dividing the field into squares of 100 feet along the side and taking an elevation at each of the corners. The benefits to be gained by contour surveys in locating and building farm ditches and borders, as a rule, far exceed the cost of such work. Besides, with the aid of such surveys the direction and size of the borders and the feed ditches or pipes can be sketched and staked out in the field in conformity to them.

SUPPLY DITCHES AND PIPES.

The location of the ditches or pipes which supply water to borders is fixed by the survey. Their capacity is gauged principally by the quantity of water which can be obtained from the canal system.

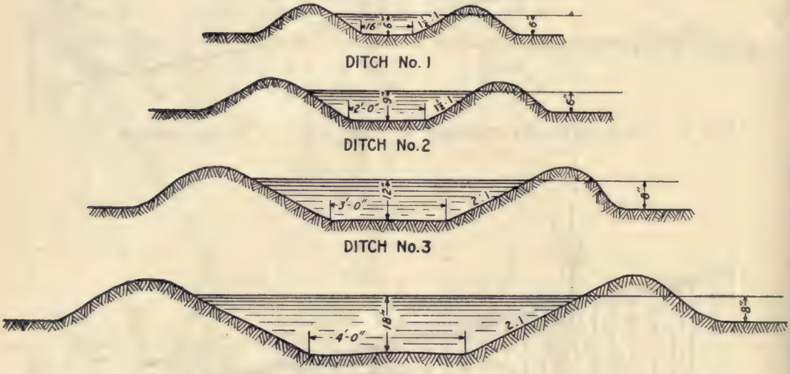

FIG. 4.—Cross sections of typical supply ditches.

Canal companies and other irrigation agencies differ widely in ways of delivering water. Quantities delivered vary from less than 1 second-foot to more than 10 second-feet, and times of delivery from a continuous stream to rotation periods of 45-day intervals. Since the conditions which govern the delivery of water from any one system can seldom be modified by the water user, he is obliged to adapt the capacity of his supply ditches and borders to the quantity of water which can be obtained from the canal system at any one time.

Four types of supply ditches are shown in figure 4. The form of these, in each case, is fixed somewhat arbitrarily, since the cross-section depends upon the kind of implement used in their construction.

Table 1 gives the mean velocity and carrying capacity of each of these typical supply ditches when running full, on a number of different grades.

TABLE 1.—*Carrying capacities of supply ditches under different grades.*

Grade.			Mean velocity in feet per second.	Carrying capacity.		
					Miners' inches.	
Inches per rod.	Feet per 100 feet.	Feet per mile.		Cubic feet per second.	Under 6-inch pressure.	Under 4-inch pressure.
Ditch No. 1: Bottom width, 16 inches; depth, 6 inches.						
¼	0.126	6.65	0.80	0.83	33	41
½	.252	13.30	1.17	1.22	49	61
¾	.379	20.00	1.41	1.46	58	73
1	.505	26.65	1.61	1.67	67	84
1¼	.631	33.30	1.80	1.87	75	94
1½	.758	40.05	1.99	2.07	83	104
1¾	.884	46.70	2.17	2.26	90	113
2	1.008	53.50	2.32	2.41	96	120
2½	1.26	66.60	2.60	2.70	108	135
Ditch No. 2: Bottom width, 2 feet; depth, 9 inches; side slope, 1½ to 1.						
¼	0.126	6.65	1.14	2.67	107	133
½	.252	13.30	1.61	3.77	150	187
¾	.379	20.00	1.99	4.65	186	232
1	.505	26.65	2.30	5.38	215	269
1¼	.631	33.30	2.57	6.02	241	301
1½	.758	40.05	2.82	6.60	264	330
1¾	.884	46.70	3.04	7.12	285	356
2	1.008	53.30	3.24	7.58	308	379
2½	1.260	66.60	3.60	8.43	367	422
Ditch No. 3: Bottom width, 3 feet; depth, 1 foot; side slope, 2 to 1.						
¼	0.126	6.65	1.43	7.15	286	357
½	.252	13.30	2.03	10.15	406	508
¾	.379	20.00	2.52	12.60	504	630
1	.505	26.65	2.89	14.45	578	722
1¼	.631	33.30	3.22	16.10	644	805
1½	.758	40.05	3.54	17.70	708	885
1¾	.884	46.70	3.84	19.20	768	960
2	1.008	53.30	4.13	20.65	826	1.032
2½	1.260	66.60	4.62	23.10	924	1,155
Ditch No. 4: Bottom width, 4 feet; depth, 1 foot 6 inches; side slope, 2 to 1.						
¼	0.126	6.65	1.96	20.6	824	1,030
½	.252	13.30	2.84	29.8	1,192	1,490
¾	.379	20.00	3.43	36.1	1,443	1,805
1	.505	26.65	3.95	41.5	1,660	2,075
1¼	.631	33.30	4.42	46.4	1,856	2,320
1½	.758	40.05	4.85	51.0	2,040	2,550
1¾	.884	46.70	5.25	55.2	2,210	2,760
2	1.008	53.30	5.63	59.2	2,367	2,960
2½	1.260	66.60	6.32	66.4	2,655	3,320

Farm ditches built in porous soil are wasteful of water because of the large percentage of the flow which is absorbed by the porous material. To prevent this loss and improve in other ways on methods of distributing and controlling water, pipes are beginning to take the place of earthen ditches. The kinds of pipes most commonly used for this purpose are concrete and a combination of wood and steel known as machine-banded pipe. Table 2[2] gives the carrying capacity of concrete pipes of average construction ranging from 6 to 30 inches in diameter and under eight different falls or grades. The discharges are given in miner's inches under a 4-inch pressure, but may readily be converted into second-feet by dividing each by 50, or into gallons per minute by multiplying each by 9.

TABLE 2.—*Carrying capacities of concrete pipe in miner's inches computed to the nearest 5 miner's inches.*[1]

Diameter of pipe.	Fall (feet per 100 feet)—							
	0.1	0.2	0.3	0.4	0.5	1.0	2.5	5.0
	Carrying capacity of pipe.							
	Miner's inches.	*Miner's inches.*	*Miner's inches.*	*Miner's inches.*	*Miner's inches.*	*Miner's inches.*	*Miner's inches.*	*Miner's inches.*
6	10	10	15	20	20	30	45	60
8	20	25	35	40	45	60	85	140
10	35	50	60	70	80	110	180	250
12	60	80	110	115	120	180	275	....
14	85	120	150	170	200	275	400	....
16	120	170	210	235	275	400	600	....
18	160	230	285	330	450	550	825	....
20	225	310	380	435	500	700	1,100	....
22	275	400	485	525	625	900	1,400	....
24	350	500	620	710	800	1,150	....	....
30	650	900	1,100	1,275	1,425	....	....	....

[1] One miner's inch is here equivalent to the one-fiftieth part of a second-foot and is nearly equal to 9 gallons per minute.

BORDER STRUCTURES.

The most common structures in border irrigation are the headgates to control the water entering each division or strip. These are made of lumber or concrete or a combination of the two. They may also be metal gates inserted in pipes. As in the case of supply or head ditches, the capacity of the headgates varies from 1 to over 10 second-feet, and it is customary to design each of such a size that it can transmit the entire flow of the head ditch or pipe. Figure 5 shows a standard single-wing headgate of wood, which may be built in three different sizes, from 1 to 8 second-feet capacity, as outlined in the table of dimensions. Figure 6 shows a set of larger gates of the double wing type, ranging in capacity from 3 to over 10 second-

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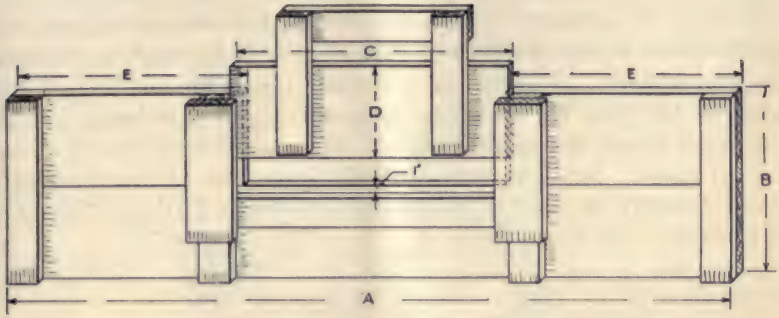
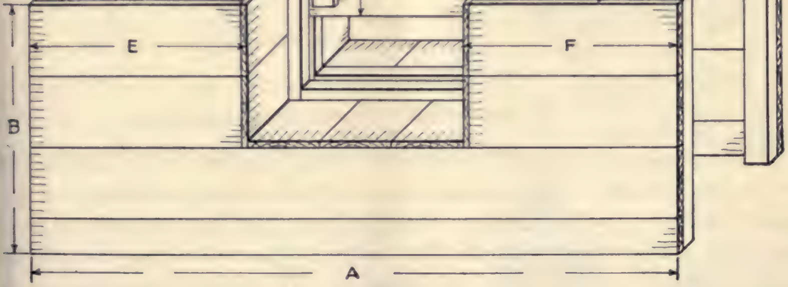
[2] From Department of Agriculture Bulletin 852.



DESIGNED FOR HEADS OF	A	B	C	D	E	LUMBER THICKNESS
1 cfs - 2 cfs	8'-0"	2'-0"	3'-0"	1'-0"	2'-6"	1"
2 cfs - 5 cfs	9'-0"	3'-6"	3'-0"	2'-0"	3'-0"	1½
5 cfs - 8 cfs	10'-0"	3'-6"	4'-0"	2'-0"	3'-0"	1½

FIG. 5.—Standard single-wing wooden head gate.

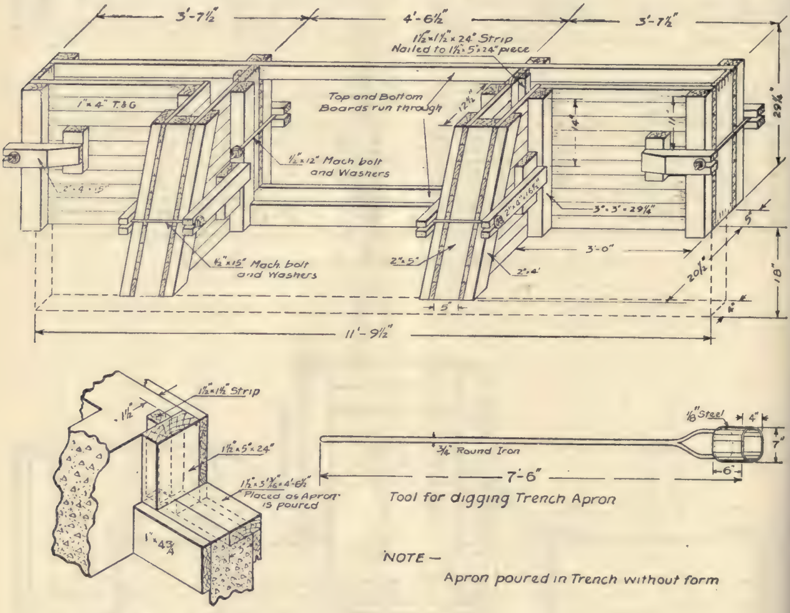


DESIGNED FOR HEADS OF	A	B	C	D	E	F	G
3 cfs - 6 c.f.s.	9'-0"	3'-6"	3'-0"	2'-0"	3'-0"	3'-0"	2'-0"
6 cfs. - 10 c.f.s	12'-0"	4'-0"	4'-0"	2'-0"	4'-0"	4'-0"	2'-6"
10 c.f.s - AND UP	14'-0"	4'-0"	5'-0"	2'-0"	4'-6"	4'-6"	2'-6"

FIG. 6.—Standard double-wing wooden head gate.

feet.[3] The latter are used for the larger heads and in light, porous soils subject to erosion.

Because of the short life of untreated lumber when in contact with earth, border headgates built of concrete are being used on a number of canal systems. The design of lumber forms for one of this type is shown in figure 7. Owing to the simplicity of this design and the ease with which it can be installed, the cost does not much exceed that of wood. Another form of border gate, also of concrete, introduced recently on the irrigation system of the Turlock district of California, is shown in figure 8.


3'-7½"
4'-6½"
3'-7½"
1½"×1½"×24" Strip Nailed to 1½"×5"×24" piece
1"×4" T.&G.
Top and Bottom Boards run through
12½"
14"
11"
29¼"
½"×12" Mach. bolt and Washers
2"×4"×15"
2"×4"×16½"
3"×3"×29¼"
5"
½"×15" Mach. bolt and Washers
2"×5"
2"×4'
3'-0"
20½"
18"
5"
6"
11'-9½"
1½"×1½" Strip
1½"
1½"×5"×24"
1½"×5 13/16"×4'-6½" Placed as Apron is poured
1"×4¾
⅛" Steel
4"
7"
¾" Round Iron
7'-6"
6"
NOTE— Apron poured in Trench without form

Tool for digging Trench Apron

Detail of Sill Form

FIG. 7.—Design of standard forms for concrete head gates.

When water is conveyed to borders through pipes, it is distributed to the head of each strip through short stands resting on the top of the feed pipe or on the top of short branch lines. In case concrete pipe is used, the valve which controls the water is inserted in the top of the concrete stand as indicated in figure 9. To reduce the number of valves and thereby lessen the cost, one valve may feed several strips in turn by means of a portable hydrant which is fastened to the stand and the requisite number of joints of galvanized steel surface pipe. A section of the portable hydrant having a connection for the surface pipe and the manner in which several strips may be watered from one valve are shown in figure 10. A similar valve attached to a steel riveted pipe is shown in figure 11.

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[3] The author is indebted to Prof. S. H. Beckett, of the University of California, for the designs of border or headgates shown in figures 5, 6, and 7.

When a check in the head ditch is needed to permit the full head to enter any one border gate, the canvas dam is about the cheapest and simplest device that can be used. It is advisable to have two such dams in order that one may be placed in the ditch at the proper distance below the one in use, before the latter is removed. Even with this help, the labor involved in shifting the dams from place to place and the disagreeable nature of the task lead farmers to adopt whenever possible more permanent and less laborious methods. For this reason, checks of wood or concrete with openings controlled by gates or flashboards are becoming more common. One of these, made of

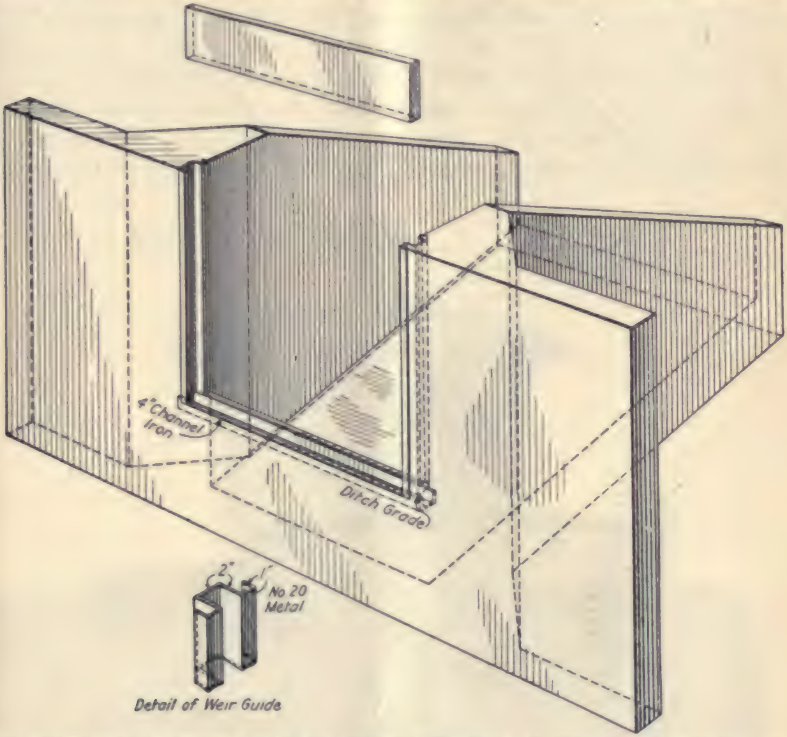

FIG. 8.—Outline of concrete gate and wooden flashboard as used on the Turlock Irrigation District, California.

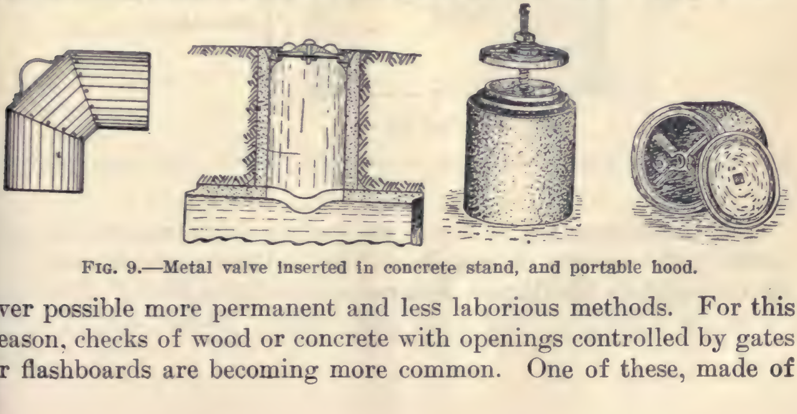

FIG. 9.—Metal valve inserted in concrete stand, and portable hood.

concrete, with lumber flashboards, designed by R. V. Meikle, chief engineer of the Turlock irrigation district, is shown in figure 12. If lumber throughout is preferred, such check gates may take the form of the double-wing border gate shown in figure 6.

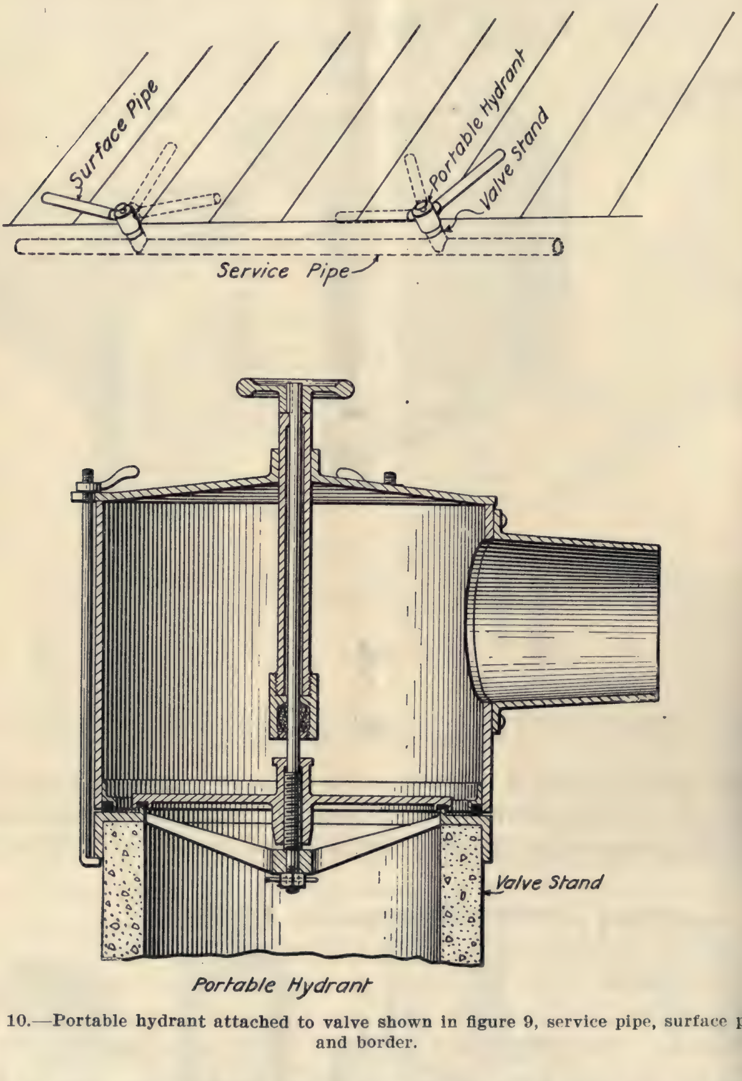

FIG. 10.—Portable hydrant attached to valve shown in figure 9, service pipe, surface pipe and border.

It is often necessary to divide the supply ditch into two or more parts by the use of a division box. One of these made of concrete is shown in figure 13. It was designed and built by Milo B. Williams, of the Bureau of Public Roads, assisted by J. R. Jahn of the California Land Settlement Board, for the land settlement colony at Durham, Calif.

When a supply ditch or other farm lateral crosses a stream, ravine, or other depression, a wooden flume on trestles has been the most commonly used structure. However, on account of the recent increase in the price of lumber and the likelihood of the early decay of wood, the use of pipes for this purpose, especially concrete pipes, has lately been rather extensive. Concrete and metal pipes are also being more frequently used for road crossings, in the form of culverts.

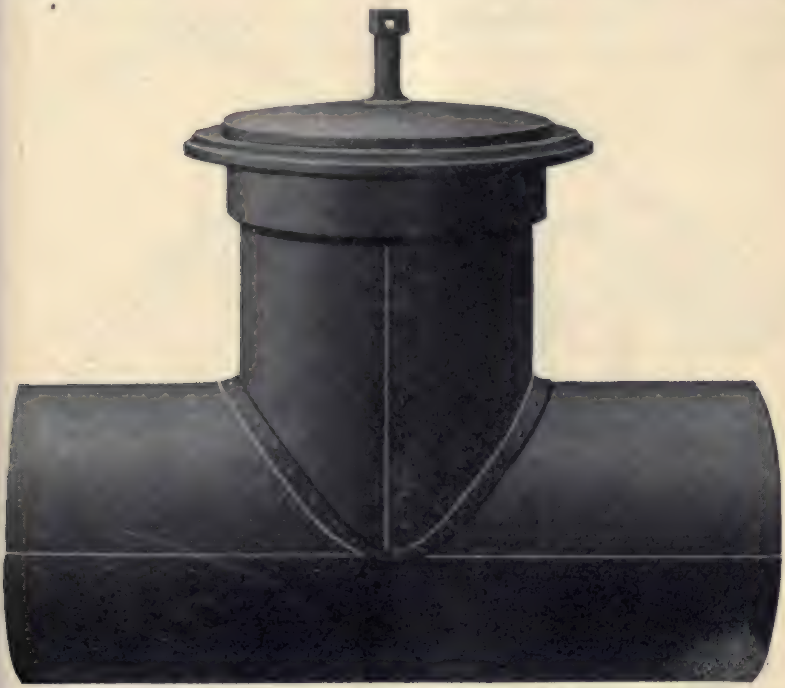

FIG. 11.—Valve for distributing water attached to a riveted steel pipe.

In case the water flows through a culvert of this kind on grade, all that is necessary, apart from the pipe itself, is suitable protection at the inlet and outlet ends to prevent the soil around the culvert from washing away. This may be prevented by throwing up embankments of earth or of mixed earth and gravel, properly puddled and packed, at each end of the pipe, or else by building head walls of concrete encircling each end of the culvert. If the bed of the ditch happens to be above the roadway the concrete walls are replaced by concrete boxes, one of which serves as an inlet and the other as an outlet.

In other cases a road culvert may be combined with a check drop or division box, or two or more of these together, in which event the combined structure can be built more cheaply than could several separate and independent structures.

PREPARING LAND FOR BORDER IRRIGATION.

A survey of the field or farm is essential in order to locate the various farm ditches and determine the width, length, and direction of the borders. Such a survey should include the making of soil borings to ascertain the depth and character of the subsoil, whether any layer of hardpan is to be found within 6 feet or more of the surface, and, if within reach, the whereabouts of the water table.

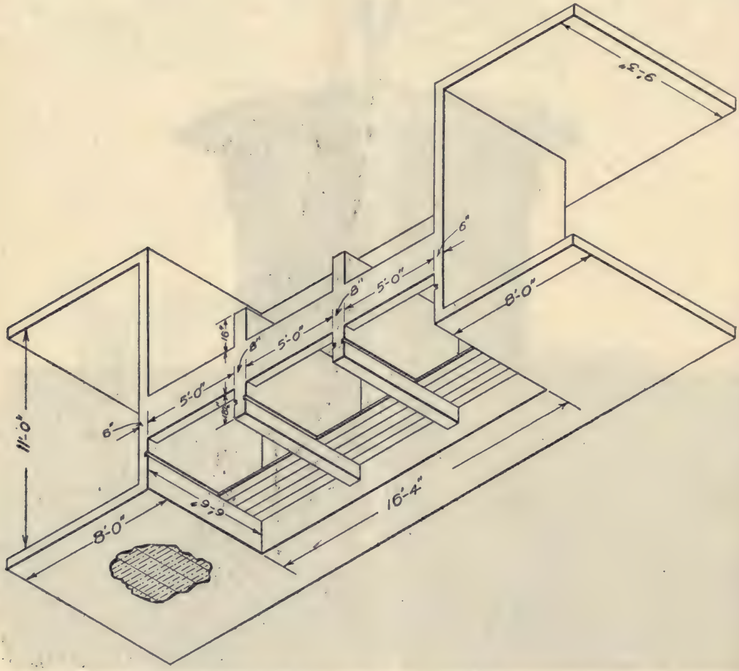

FIG. 12.—Concrete check gates on laterals of the Turlock Irrigation District, California.

The width and the length of borders vary with the head of water available, the texture of the soil and subsoil, the slope of the land, and to a less extent with the kind of crop grown and the amount of money available for such work. While the small-sized border tends to insure a more uniform moistening of the soil with the least waste of water, it necessitates the building and maintaining of more field ditches and structures and a larger number of field levees, both of which are objectionable features from the farmer's standpoint.

On the other hand, long borders in porous soils waste a large amount of water by deep percolation and are likely to show an uneven distribution of moisture in the upper layer of soil. In deciding upon the proper size of borders to use, certain factors such as the slope of the land and the character of the soil are more or less fixed, and it is only the size of the borders and the head which are subject to change. From this it is evident that a careful adjustment should be made so as to make the latter conform to the other main factors. For instance, in the question of the head to use, if the soil contains large percentages of clay and silt and does not moisten readily, the flooding of the surface with a large head for a short time might not wet the soil more than a few inches deep, whereas by allowing a small amount of water to run for a long period, a much deeper penetration of moisture can be secured. In the case of porous soils which absorb water readily, there is a decided advantage in the use of large heads which move over the surface rapidly and thus prevent too deep peneration.

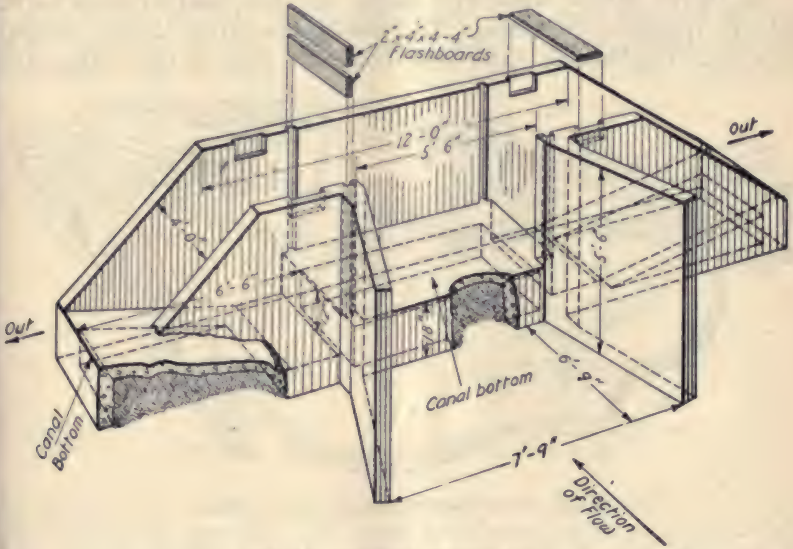

FIG. 13.—Concrete division box.

The field to be prepared for border irrigation is first plowed or disked. In case the soil is too dry and hard to allow this to be done successfully, it is watered as well as its nature will permit. Occasionally the ground is first leveled in a rough way by teams or tracors and afterwards divided into strips and borders. The location of the border levees is indicated by long stakes which may be made of half laths, and when these are set, a straight plow furrow is run between stakes to mark in a more definite way the location of each border. A foundation for a border may be made by plowing two or three furrows on each side of the staked line, throwing the dirt toward the center. For small tracts the levees are built usually by the use of three-horse and four-horse Fresno scrapers, which are driven back and forth at right angles to the levee lines. As the earth is scraped from the high spots it is carried forward and dumped on each levee in passing. The amount of earth dumped on each levee depends on how far the scraper loads are overlapped. If large levees are required, two or more scraperfuls of earth may be dumped in the same place, but in small, low borders a slight overlapping of the loads may suffice.

The border levees, when first made, are composed of loose earth and are irregular in shape. To remedy the latter defect, several homemade implements have been devised. One of these (fig. 14) is a wooden drag, trapezoidal in shape, drawn with the large end ahead. A common two-section drag harrow may also be used to advantage. A hinge should be placed in the middle of the evener bar, to allow the harrow to lap down over the sides of the levee as it is drawn lengthwise of the border.

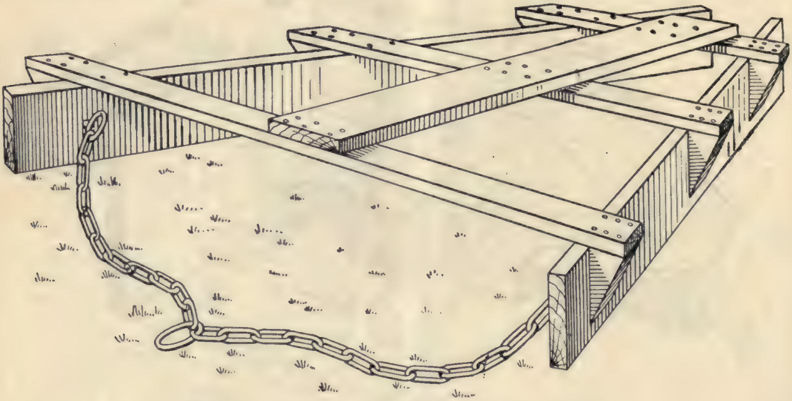

FIG. 14.—Drag used to prepare border levees.

After the levees are built the space between each pair is carefully leveled and graded by an implement somewhat similar in design to that represented in figure 15. In properly prepared fields the standard requirement for this part of the work is that the surface shall be practically level crosswise between borders, the greatest variation in elevation permissible being about one-tenth of a foot. Such close attention to grading is necessary in order that the water may flow down the strip in a thin sheet of uniform depth. Otherwise it is certain to seek the lowest levels and may leave the higher spots unwatered or only partially watered.

Less attention need be paid to the grade in the direction of the border. It is not always necessary that the grade be uniform from top to bottom. It is desirable to make the upper end of the strip level, i. e., without grade, for a distance from the intake nearly equal to the width of the border strip. This causes the water, when first admitted through the gate, to spread out sidewise and submerge all the space between the side levees before it begins to flow down the slope. The slope from this point to the end of the strip may or may not be uniform. To make a uniform grade often necessitates the removal of a large amount of surface earth over considerable distances, which increases the cost of bordering and lessens the yields on the excavated portions. If the surface of the ground is such that a uniform grade can not readily be obtained, it is important to have, if practicable, the steepest grade near the lower end of each strip. The reason for this arrangement is that the water, as will be pointed out later, flows more slowly as it approaches the lower end, and if the grade in this part is increased it in turn causes the water to move faster and thus tends to produce a more uniform flow throughout.

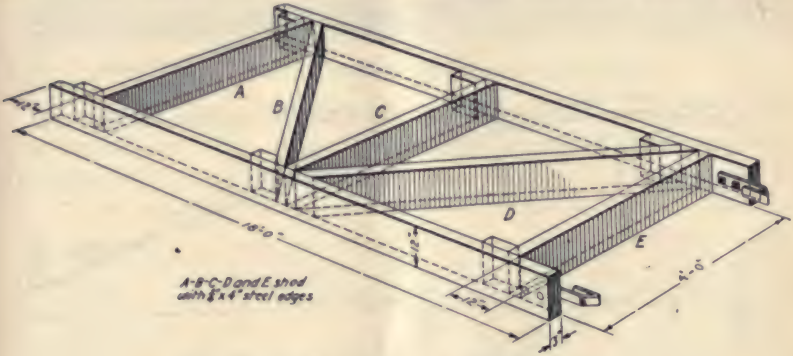

Fig. 15.—Rectangular drag for levelling land.

The question of proper grades for borders may be better understood by a reference to the profiles in figure 16, which indicate in each case the original surface of the ground before any grading or leveling is done and the established grade of the completed border. In the upper profile the natural slope of the ground does not vary much, and accordingly the grade of the border is made uniform throughout with the exception of the level part near the intake. In the next profile the surface is more uneven, calling for more earthwork in cutting down the high and filling up the low spots. A uniform grade is not possible in this case without heavy grading, involving extra cost, and to avoid both, the grade is made to conform to the natural surface which has its greatest fall in the lower half. This is a desirable feature, particularly in long borders. The profile shown at the bottom of the figure is objectionable, chiefly because the slope is greatest in the upper part of the border.

SPECIAL METHODS USED IN PREPARING LAND.

When the surface of the land to be irrigated is irregular, consisting of sand dunes or what are locally termed "buffalo" or "hog wallows," a tractor operating a large steel leveler or scraper is frequently employed to do the rough grading. Figure 17 shows one of these implements being operated by a tractor. Air is compressed by the tractor and conveyed through a pipe and hose to an air tank attached to the leveler in the rear. By means of the compressed air, the leveler is operated in an effective way, being readily forced into unplowed soil of more than ordinary compactness.

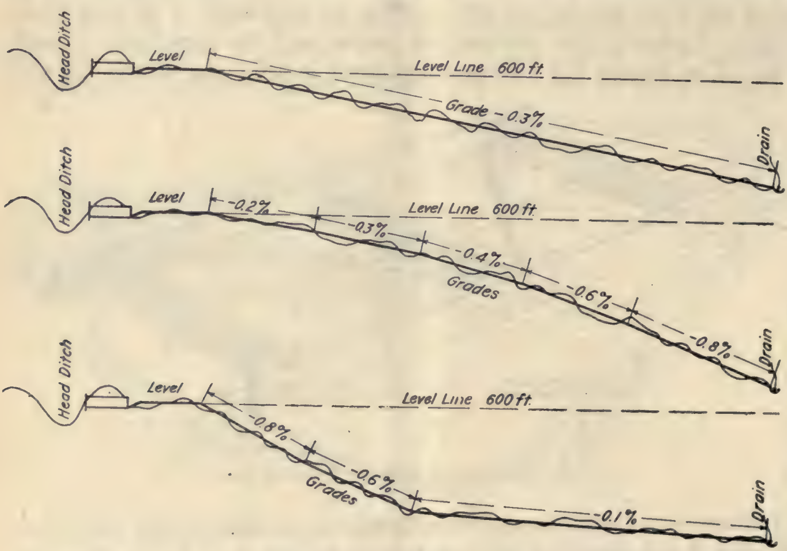

FIG. 16.—Profiles of typical border strips showing surface before and after grading.

A trapezoidal drag of large dimensions operating on wheels and regulated by a lever is shown in figure 18. By means of these two implements a large area of rough land can be prepared quickly for border irrigation with a minimum of manual labor.

Border levees are sometimes made with a road grader (fig. 19). When this implement is used for this purpose the most common method followed is first to throw up a couple of back furrows with an ordinary plow, to mark the location of each levee. The road grader then makes one trip around the back furrows, throwing additional earth on the levee thus formed. After this is done the grader is shifted to the center of the border strip and with each round crowds the surface earth toward the partially formed levee. For work of this kind the cutter should be set at an angle of about 45°. So set, ordinary graders cover a width of about 6 feet.

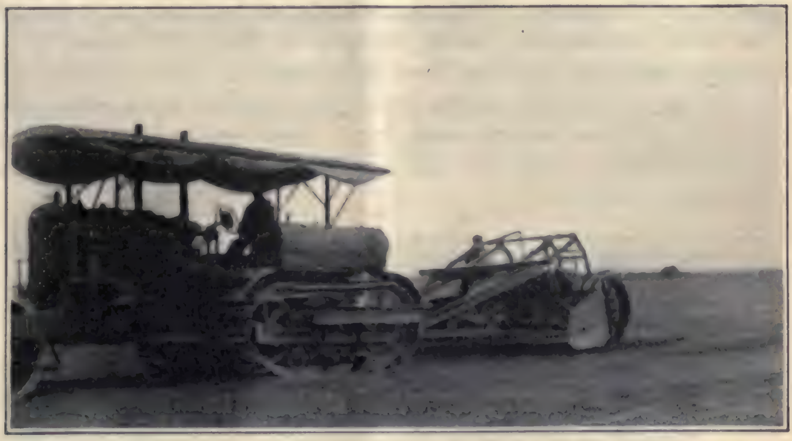

FIG. 17.—A caterpillar tractor drawing a land leveler.

In compact soils great difficulty is sometimes experienced in getting irrigation water to penetrate to the depth of the lowest roots. It frequently happens that when water is applied in the usual way such soils are not moistened beyond the top 6 inches. The running of a small stream for a long time over tight soils increases the depth of penetration. There are types of soil, however, to which this method will not supply sufficient moisture to the second and third foot of soil. In this event, the so-called check-borders may

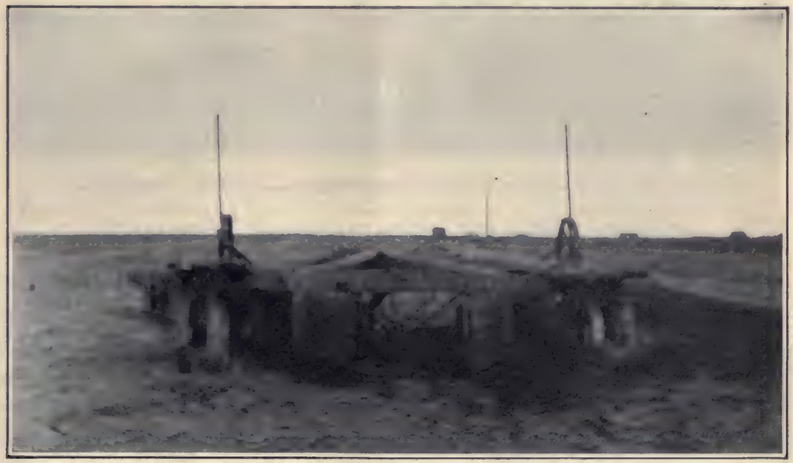

FIG. 18.—Large drag on wheels used in preparing land for border irrigation.

be used to good advantage. This modification of the common border method consists in forming a low dike or ridge by two back furrows at right angles to the border levees and 100 feet or more apart, depending on the grade. With this change each border strip becomes a series of rectangular checks in each of which the water is impounded until the soil has been moistened to the required depth. By placing a piece of canvas over a low part of these cross dikes the water may be held in each for a considerable time, providing the temperature of the air and water is not high enough to scald such crops as alfalfa.

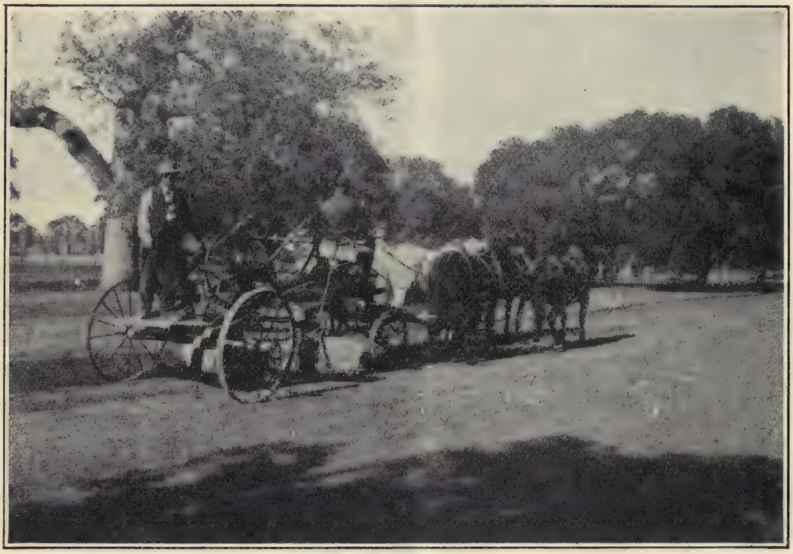

FIG. 19.—Road grader used in preparing land for border irrigation.

EFFICIENCY OF THE BORDER METHOD.

The rate of advance of water as it moves down a strip may serve to indicate the efficiency of the application. Experiments conducted by P. E. Fuller and J. C. Marr of the Bureau of Public Roads in the Salt River Valley of Arizona, using 8.5 second-feet of water in border strips 50 feet wide and 600 feet long (fig. 20), showed a slight decrease in the moisture content at the lower end, but on the whole the distribution of moisture was fairly uniform. On border strips 1,000 feet long (fig. 21) it was found that there was a fairly uniform distribution of water in the soil until the 600-foot station was reached, but with the exception of the top foot of soil, little if any water penetrated into the soil near the lower end.

So long as the water advances at a uniform rate, the loss of water by deep percolation in porous soils is not great. On the other hand, when the runs are too long, the time required to irrigate the lower parts of the strips is much increased, causing a corresponding increase in the loss of water due to deep percolation. The remedy lies in the use of shorter runs and larger heads.

Another method which is being employed by the author and W. W. McLaughlin of the Bureau of Public Roads to test the efficiency of an irrigation is to determine at what point the soil becomes so dry that plants begin to suffer. This is the so-called wilting point, which varies with the kind of soil, it being low in sandy soils and high in clay soils. In the lighter soils of the Salt River Valley, Ariz., it is about 5 per cent by weight, of the dry soil. In the medium volcanic soils of southern Idaho it is about 10 per cent, and in the adobe soils of the rice belt of California it is about 15 per cent. After the wilting point of the soil under consideration is determined, it is then necessary to ascertain what amount of moisture the soil will retain against gravity to a certain depth. Assuming the wilting point of the soil under test is 12 per cent and that its total water-holding capacity immediately after being irrigated is 24 per cent, the difference of 12 per cent when converted into acre-inches of water

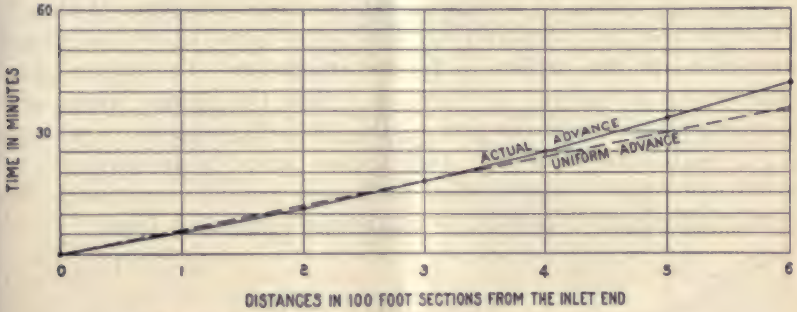

FIG. 20.—Rate of advance in a border strip 600 feet long.

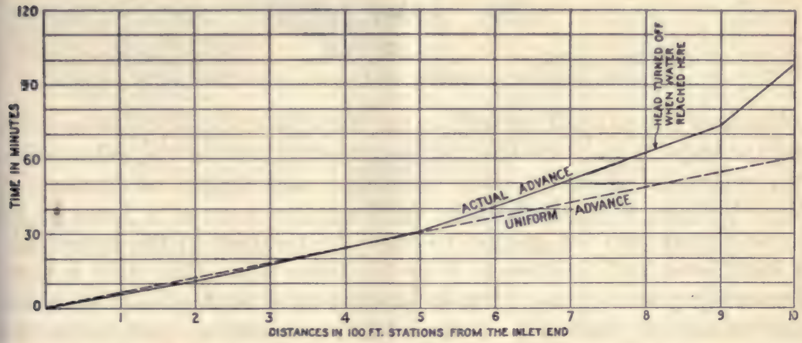

FIG. 21.—Rate of advance of water in a border strip 1,000 feet long.

represents all that the soil will hold in a layer of known depth and all that should be applied at any one time.

ARIZONA PRACTICE IN PREPARING BORDERS.

Prior to the growing of cotton on a large scale fully 75 per cent of the irrigated area of Arizona was watered by the border method, and although cotton, to a large extent, has taken the place of alfalfa as a staple product, comparatively few border levees have been graded down to adapt the surface to furrow irrigation. The cotton plant while young is watered by furrows within the border levees, and when the plants shade the ground the following method is resorted to with satisfactory results. During the period when furrow irrigation is necessary, smaller heads of water are delivered unless the force is sufficiently increased to handle the customary head.

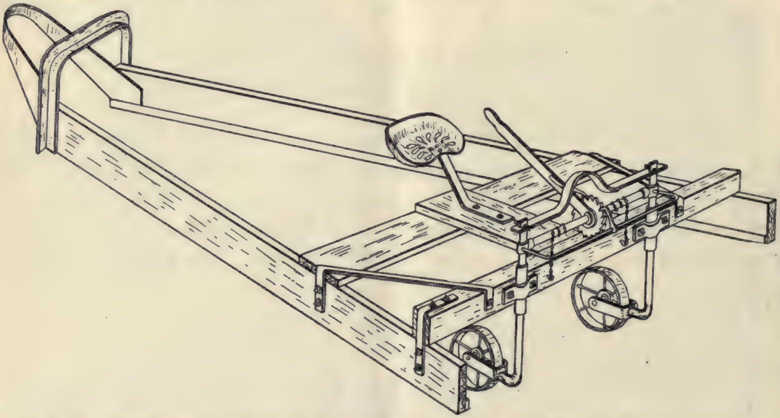

FIG. 22.—Bordering machine as designed and used in Salt River Valley, Arizona.

Much of the natural surface of the Salt River Valley is so smooth and the slope so uniform that little surveying is required preliminary to preparing borders. After the width and length of borders is decided upon, a flag is fastened to the upper wire of a fence or to a pole thrust into the ground to show the location of the upper end of each levee and another to show the lower end. The field is then plowed by placing back furrows at each levee with a dead or blind furrow midway between. Some such implement as that shown in figure 14 is then drawn along the levee and the back furrow is graded up with Fresno scrapers. A company growing cotton has modified the ordinary trapezoidal ridger (fig. 14) by attaching a metal frame to the rear end for the purpose of reducing the top of the levee to an even grade and otherwise making it more regular. This device is shown in figure 22. The space between border levees is smoothed and graded by a drag similar in design to that shown in figure 15.

Large heads of 7 to 10 second-feet are the most common, but the manner in which these large heads are checked and diverted into the border strips varies somewhat. The simplest and least expensive method is to check the flow in the supply ditch by a canvas dam and remove with a shovel a part of the lower embankment, allowing the water to flow into the border for about two hours or until the water has reached within 200 feet or so of the end of its run, when the earth taken out is replaced and the canvas dam shifted to a higher point.

The canvas dam (fig. 23) consists of a framework of lumber with a tarpaulin about 7 by 14 feet spread over it, and pressed into the soft earth at the bottom and sides. The lumber usually consists of a round pole or sawed joist placed across the ditch with the ends resting on the banks. Then lighter poles are placed in a slanting position on the upstream side with one end in the bottom of the ditch and the other resting on the crossbar. The latter is allowed to remain in place when not in use and the smaller sticks are placed on the bank beside it.

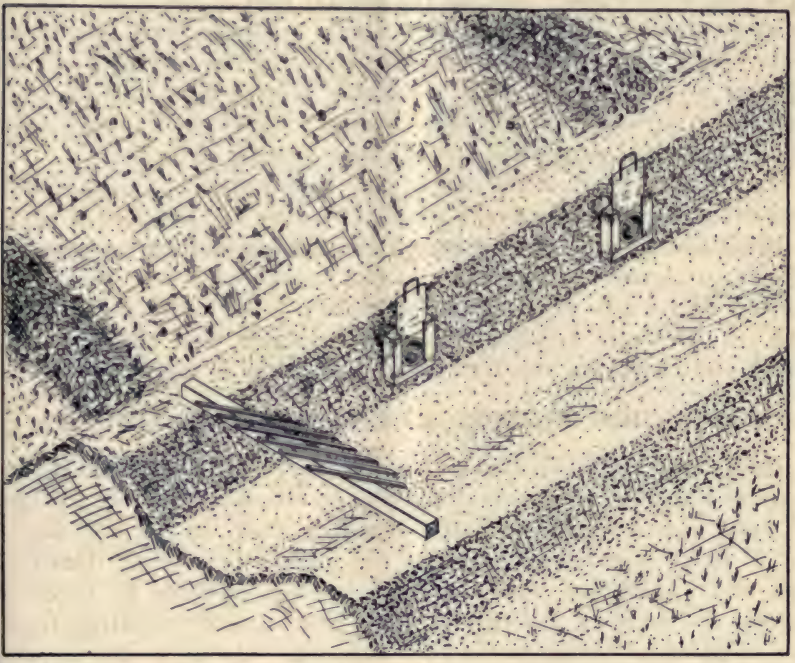

FIG. 23.—An Arizona head ditch with frame for canvas dam and two border gates.

To lessen the labor involved in the method just described, it is common practice to install check and border gates. These are made of wood or concrete and do not differ essentially from those already described. A border gate which is gaining in favor is made of several joints of concrete pipe of the required diameter with the upper opening controlled by a metal slide as indicated in figure 23. In putting in such gates, care should be taken to tamp moist earth around them in order to prevent erosion at the bottom or sides.

In Arizona the most common width of border is 50 feet and the most common length one-quarter of a mile. Perhaps the chief mistake which has been made in preparing land for border irrigation in this State has been the adoption of long runs regardless of the type of soil. Where the soil is deep and porous, large quantities of water are readily absorbed and drawn down by gravity beyond the deepest roots. In this type of soil it is not possible to irrigate the lower end of a long strip without wasting the greater part of the water turned in at the head. The remedy is to divide a 40-acre tract into three belts with a head ditch for each, thus reducing the length of run to 440 feet or less. If the slope is suitable, a large head will advance at a fairly uniform rate over this distance without much loss by deep percolation and bring about a fairly even wetting of the soil.

On the other hand, in the case of clay loam soils, or of porous soils overlying impervious layers, a length of border of 1,300 feet or more is often warranted. Soil-moisture determinations have been made after an irrigation by engineers of the Bureau of Public Roads, on borders half a mile long, which indicated a fairly uniform distribution of the water applied without appreciable loss, although the water was allowed to run for two to four hours on each strip.

THE BORDER METHOD AS PRACTICED IN NEVADA.

The Bureau of Public Roads, in cooperation with the Nevada Agricultural Experiment Station, is making an economic study of the use of water as practiced near Battle Mountain, Nev., in the wild flooding of native meadows, comparing the present practice of distribution and application with the more modern methods of borders, checks, and furrows, and recording the gain in profit resulting from the adoption of better methods of farming. Owing to the imperviousness of the soil in this locality, the water does not penetrate readily to sufficient depths without the aid of low cross dikes spaced 100 feet or more apart. The effect of these is to make border checks, in each of which the water is pooled until the soil is moistened to the required depth.

Where border irrigation is practiced in the valleys of the Humboldt, the borders are usually made both wide and long. The borders of the Lovelock Valley vary from 1,000 to 5,000 feet in length and from 60 to 90 feet in width, and large volumes of water are turned into them during the river's flood periods. In the preparation of these borders the field is first leveled with a grader and then marked off into borders. A large trapezoidal wooden frame, mounted on wheels and controlled by a system of levers, of the type shown in figure 18, is then used to form the border levees, the entire practice being adapted to large holdings and the use of large heads.

On the Newlands Government project in Nevada there are rolling sand-hill lands which require large expenditures for grading before they can be made ready for growing crops. In preparing such lands for border irrigation the customary practice is to make a contour survey with contours 6 inches in vertical elevation. From this survey the direction and amount of the slope and the location of the supply and drain ditches are determined. The surface is then roughly leveled by the use of tractors drawing large scrapers, which can be operated on sandy soils without previous plowing. On firmer soils deep plowing should precede the grading process. About 1,000 acres were rough graded by tractors in 1917 at a cost ranging from $26 to $40 per acre. The making of the borders and the final smoothing and leveling were left to the individual settlers to perform. The usual size is 65 feet wide and 660 feet long on slopes running from one-tenth of a foot to 3 feet per 100 feet.

THE BORDER METHOD AS PRACTICED IN OREGON.

The border method has not been practiced long in either Oregon or Washington, but the success which has attended its introduction in both States bids fair to make it popular wherever the conditions are suitable. It is well adapted to conditions in the Willamette Valley and it will doubtless be very generally practiced when the lands now dry-farmed are irrigated. This method is being used for grain and fodder crops on peat and tule lands in the central part of the State east of the Cascades. It is also being used successfully on the light soils, some of which are blowsands of the Columbia River basin. On the Umatilla project near Hermiston, Oreg., the average duty of water in 1912 was 9.7 acre-feet per acre, but in 1919 it was reduced to 5.65 acre-feet per acre. The more economical use of water on this project has been brought about largely by the adoption of small-sized borders (fig. 24) and the delivery of large heads in rotation periods. R. W. Allen, formerly superintendent of the Umatilla branch experiment station, and his successor, H. K. Dean, have investigated for years the best methods of irrigating the light soils of this project, and the results of their labors can be applied profitably throughout the West on the lighter type of porous soils. The following extracts from a circular on "Border Irrigation for Porous Soils" by R. W. Allen will convey some idea of the essential features of this method as adapted to this type of soil.

> As a result of eight years of study of methods of irrigating porous soils at the Umatilla branch experiment station, and observations made of the success and value of different methods of irrigation on porous soils on many irrigation

projects throughout the West, it has been found that border irrigation offers the best known means of applying water to soils of an open, porous, sandy, or gravelly nature.

The width, length, and shape of the borders should depend upon the character of the soil, slope of land, and the size of the head of irrigation water available. On coarse soil they need to be small so as to be quickly covered to prevent waste of water by deep percolation. On shallow soil they should be made small enough to irrigate quickly, in order to prevent excessive irrigation and the consequent complications of a water-logged soil, or seepage spots in the field.

The length of borders should range from 70 feet on very coarse or steep soil to 300 feet on moderately sloping land of fine texture and good depth. The average length of borders should be about 200 feet. The width ranges from 20 to 40 feet.

On land having rough topography, the borders can be made with a minimum of expense in grading by making them in a variety of shapes to conform to the slope of the land, V-shaped, fan-shaped, and L or crescent shaped borders are not uncommon.

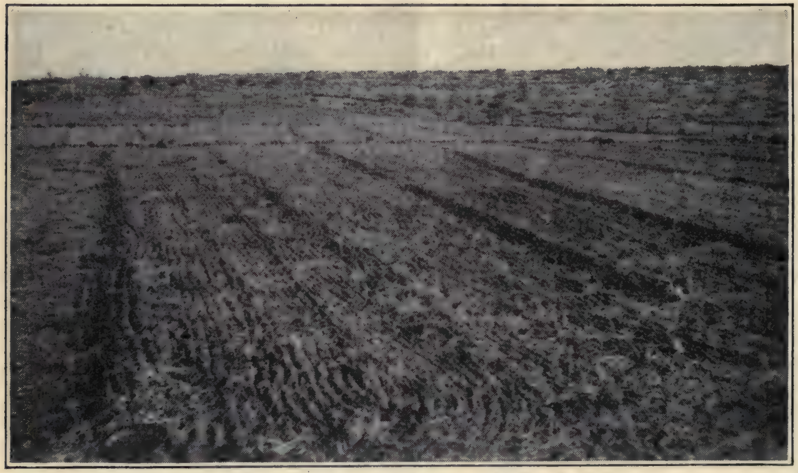

FIG. 24.—Small borders for porous soils as practised on the Umatilla Project in Oregon.

It pays, and pays big, to have land in good condition for irrigation. The following data on two tracts of land show actual conditions on this project. Both tracts are of the same size, have similar soil, and were irrigated by the same man.

An irrigation head of 3½ second-feet of water was used. To the first plot 3½ inches of water was applied in one hour at a labor cost of 12½ cents; labor figured at $3 for a 24-hour day. To the second plot, 16⅝ inches of water was applied in 4¾ hours at a labor cost of 59⅜ cents per acre.

The first field was bordered and well leveled, with turnout boxes of good size. There is no duplicate irrigation. This saves time and water. Time and water saved is money saved. The second field was irrigated by free flooding. The land is uneven. Water is hard to control. The effect is duplicate irrigation, loss of time, and waste of water. Time and water wasted is money lost.

The levees, when made, should be about 18 inches to 2 feet wide and 1 to 1½ feet tall. As soon as the land is graded, it should be irrigated to settle all loose places and to determine how the water flows over it. While water is on the borders, it is a good practice to get in with whatever implements are necessary and do all the work needed to make the water flow perfectly. Working this character of soil wet does it little if any damage.

As soon as the land is properly leveled for irrigation, precaution should be taken against wind erosion. It should be covered lightly with straw, about one-half to three-fourths ton an acre, and sown to rye at the rate of 30 to 40 pounds an acre. Where the soil is very sandy and subject to serious erosion and when irrigation water is not available with which to insure rapid growth of the rye, extra care should be used to prevent erosion.

The straw should be made fast to the ground by running over it with a disk harrow set straight to bury part and leave the remainder standing in the air. This serves as a windbreak by reducing the velocity of the wind at the surface of the land. Coarse manure or fine brush can be used to advantage instead of straw.

Suggestions to new settlers on the Umatilla project regarding cultural and irrigation methods in farming blowsands have been issued by Paul S. Jones, formerly connected with the Umatilla branch experiment station. The most pertinent of these suggestions which relate to irrigation are summarized in what follows:

As regards the construction of supply ditches, in most cases the settler builds them of too small capacity for economical irrigation. They should have a capacity of over 2½ cubic feet per second. In many cases heads of 3 to 5 cubic feet per second can be used without excessive erosion.

After a supply ditch is staked out, it is well to smooth a strip along its course 25 feet wide above the ditch line and about 50 feet below. This work consists in grading to a uniformly smooth surface all hummocks and depressions within this area by the use of Fresno or buck scraper and a rectangular float. The border levees are then built from 30 to 50 feet apart and from 150 to 300 feet in length. As each strip is completed, it should be thoroughly irrigated.

Particular care in handling the water is required until the land is cropped, when the plant root systems and surface growth will retard the flow of water and minimize erosion.

After the first irrigation is applied, the rectangular float may be again used for a final smoothing, after which rye is drilled in (over levees and all), sowing an extra amount at the upper end of each strip where more or less erosion usually takes place. Straw or manure covering is then disked in, the disks being set straight to press in the straw and so as not to roughen the surface (fig. 25). The area thus protected has the appearance of a stubble field.

Just as soon as the rye forms a protective covering, drill in the alfalfa seed immediately after a thorough irrigation over levees and all. If the growing rye should later threaten to choke out the young alfalfa plants, it may be clipped at intervals to relieve this condition.

From this stage on the surface soil must be kept moist by frequent light irrigations, until the alfalfa plants are 3 or 4 inches high. This is the critical time in the life of these plants, and they will not survive if not given the much needed surface moisture.

For a number of years experiments have been carried on at the Umatilla experiment farm near Hermiston, Oreg., to determine the proper length and width of border strips for the porous soils of that locality. The lengths adopted were 100, 175, and 250 feet and the widths varied from 20 to 40 feet.

On the Umatilla project check gates, drops, and turnouts are commonly made of concrete without the use of lumber forms. The banks are first put into proper shape and the concrete is then plastered over the surface to be covered. The gate grooves are formed by inserting the gates into the green concrete before it is set. This somewhat novel construction is shown in figure 26.

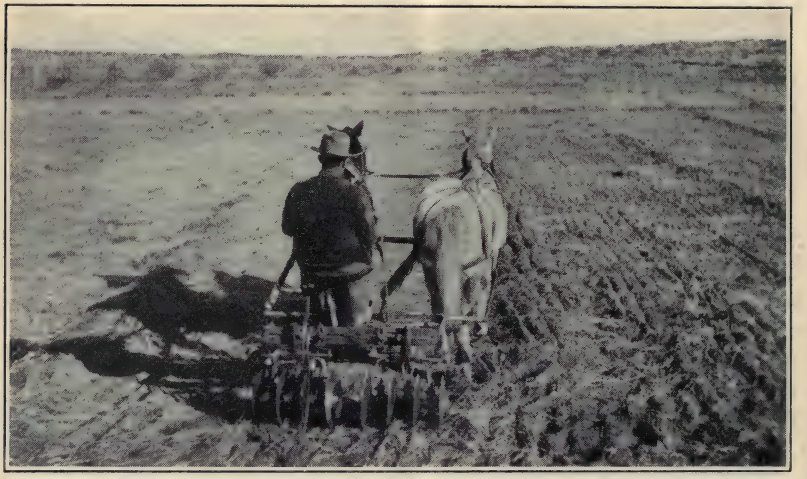

FIG. 25.—Disking straw to prevent wind erosion on borders of Umatilla Project, Oregon.

THE BORDER METHOD AS PRACTICED IN IDAHO.

A large part of the irrigated land of Idaho is underlain with rock of volcanic origin. Owing to the porosity of this lava rock and to numerous cracks and fissures, a large percentage of the water used in irrigation is lost by deep percolation. Careful studies have indicated that the loss from this cause has frequently amounted to over 60 per cent of the water applied to the more porous types of soils.

The practice, still too common under private-irrigation enterprises in Idaho, of delivering water in continuous streams instead of in rotation, is another cause of waste. A common stipulation of water-right contracts is that water shall be delivered continuously during the season at the rate of 1 second-foot for each 80 acres of land, and where the farms are 80 acres or less, the amount is altogether too small for a serviceable or economical head. A great saving in water and labor could be effected and larger yields obtained by the use of 4 second-feet every eighth day on a 40-acre farm.

In cooperative investigations by the Bureau of Public Roads and the State of Idaho, the amount of water used on 52 typical borders in different parts of the State was determined. These borders varied from 16.5 feet to 100 feet in width, averaging 67 feet, and the length varied from 250 to 2,560 feet, averaging 1,335 feet. The heads used varied from 1.4 to 7 second-feet and the depths of water applied at each irrigation from less than 2 inches to over 2 feet.

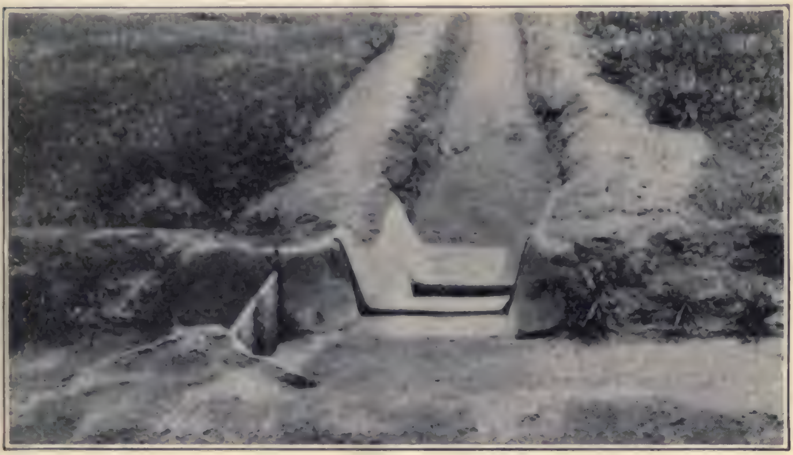

FIG. 26.—Check gates and drops made by plastering concrete on the sand as used on the Umatilla project, near Hermiston, Oreg.

On a field of red clover near Rigby, Idaho, composed of gravelly soil, the borders were 2,359 feet long. On August 25, 1910, when the second crop of clover was 14 inches high, 2¼ second-feet was turned into one of these long borders. The water advanced over one-seventh of the distance, or 337 feet, in 1 hour and 22 minutes, applying to the soil of this upper portion an average depth of 7½ inches. The velocity of the water, however, became less and less as it advanced, and it required 7 hours to traverse the last 337 feet. The total time required to irrigate the strip was 22 hours and 42 minutes and the average depth of water applied was 20 inches.

The test just described calls attention to a prevalent defect in the border method as practiced in the sandy and gravelly soils of the State. The remedy which is being applied gradually is to use more head ditches, shorter runs, and larger heads of water.

In Idaho, border levees are sometimes made by earth taken from each side, but unless these depressions are refilled in grading between border levees, the bulk of the water flows within them, leaving the center of the strip dry or only partially watered. The Idaho method of making borders is illustrated in figure 27.

Another practice is to make corrugations or small furrows between the border levees when the alfalfa or grain crop is seeded, so as to facilitate the even distribution of water during the first stage of crop growth. Similar furrows are also used on steep border slopes to prevent the erosion of young alfalfa plants by the action of large heads on sandy soil. By the time the small furrows fill with earth and sediment the alfalfa is well established by deep rooting.

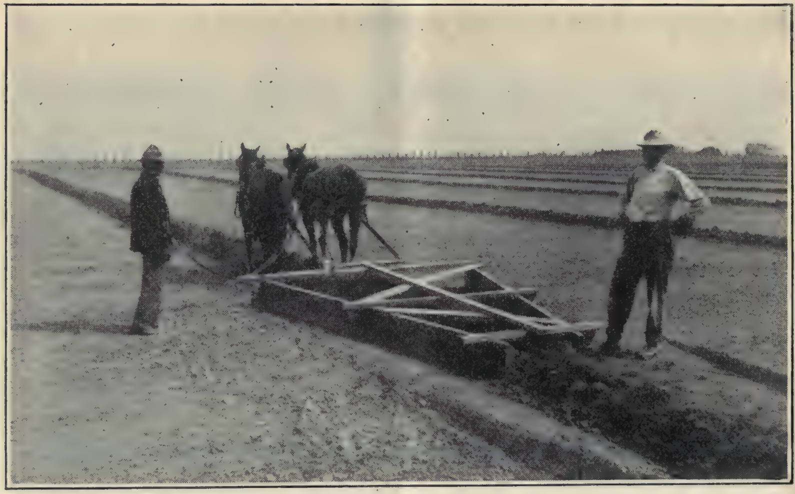

FIG. 27.—Preparing land for the border method of irrigation near Twin Falls, Idaho.

THE BORDER METHOD AS PRACTICED IN SOUTHWESTERN TEXAS.

On about one-half of the irrigated land in Texas, exclusive of the rice belt, the border method is used. If Arizona presents one extreme in the use of long borders, Texas presents the other in short ones. The largest areas inclosed between border levees are intended for the irrigation of alfalfa and grain, but these seldom exceed 25 feet in width and 330 feet in length. As might be expected, the levees and the heads of water used are correspondingly small. A large part of the water is derived from pumping plants, and the heads vary from 200 to 1,500 gallons per minute, or from less than one-half a second-foot to over 3 second-feet. Where gravity water is available, the heads vary from 1 to 5 second-feet. The head or supply ditches are built in earth as a rule, with their lowest portion about on a level with the ground surface. The grades vary from one-half to 1 inch per 100 feet, and the cross-section is sufficient to carry the amount of water available. If the head is small, a metal tappoon is often used as a temporary check gate in the supply ditch. In the case of large heads, the water is checked by the canvas dam or by permanent check gates of wood or concrete.

In the irrigation of truck crops on the Lower Rio Grande, the strips or "beds," as these are locally termed, are made much smaller than they are for forage and grain crops. Common sizes for truck crops vary from 10 to 15 feet in width and from 100 to 200 feet in length. The levees for such strips have a base width of about 3 feet and a flat crown of about 6 inches when settled. When so built, they offer little obstruction to the passage of farm implements or loaded wagons. These levees are made in raw land by dirt removed from the high spots by graders or scrapers. When the land has been in cultivation they are made by two or four back furrows to start with and finished off by the use of a buck scraper, crowder, or road hone.

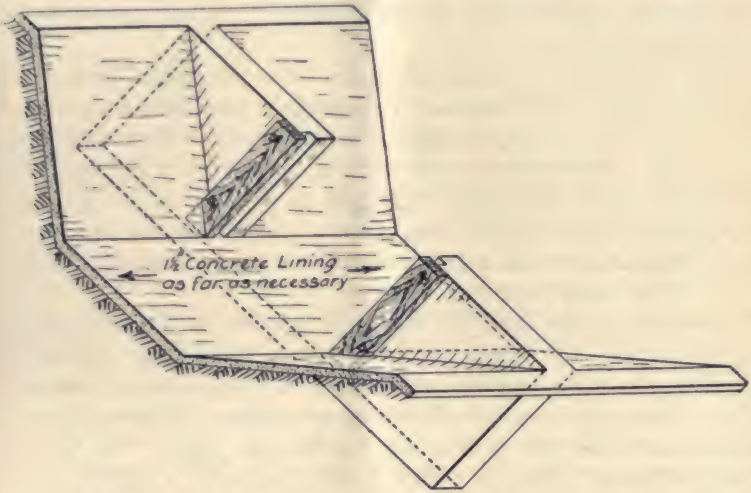

FIG. 28.—Check gate used on the Orland project, near Orland, Calif.

The time required to irrigate Texas borders depends on the soil and the volume of water turned on. A border 25 feet wide and 300 feet long may be watered in 15 minutes to an average depth of 2 feet in loam soil by a head of 900 gallons per minute or 2 second-feet. In tight soils, smaller heads should be applied for longer periods so as to allow the water to penetrate into the soil the required depth.

THE BORDER METHOD AS PRACTICED IN CALIFORNIA.

The greater part of the arable and irrigable land of California is adapted to the border method, particularly in the Sacramento, San Joaquin, and Imperial Valleys. Because of the wide variation in the absorptive properties of soils and in the quantities of water delivered, the sizes of border strips vary. According to Beckett and Robertson,[4] the border strips in the Sacramento Valley range from 30 to 120 feet in width and from 60 to 1,750 feet in length, the usual width being from 30 to 50 feet and the usual length from 400 to 700 feet. The same authors recommend that the heads used on the heavy soils be not more than about 40 per cent of those used on the medium loams. They also emphasize the necessity of a proper relation of the quantity of water used to the type of soil, and the size of each strip irrigated. The most common border gates used in this valley are shown in figures 5 and 6. A concrete check gate in which some lumber is used, similar in type to that shown in figure 28, is very generally used on the Orland project.

In the San Joaquin Valley, when the lands which had been devoted to grain raising under the natural rainfall were first irrigated, the custom was to use large rectangular or contour checks surrounded by heavy levees. In the later practice, the checks were reduced in size but without a corresponding reduction in the size of the levees. In recent years, many of these checks have been converted into borders, but the border levees as a rule are still too large, making it difficult to cross fields with farm implements.

In preparing new land for border irrigation in the medium loam soils of this valley, the best practice seems to call for borders not over an eighth of a mile long and about 50 feet wide, with low, flat levees which do not interfere with farming operations. Where the surface is rolling and the soil porous, the borders are small. On the State Land Settlement colony at Delhi, Calif., the borders vary from 15 to 30 feet in width and from 300 to 600 feet in length, with grades of one-tenth of 1 per cent to 6 per cent and heads of one-half a second-foot to 2 second-feet. The water for this colony tract is conveyed and distributed in concrete pipes ranging from 6 to 30 inches in diameter; hence most of the structures which are being installed (March, 1921) differ essentially from those used on gravity systems and earthen channels. The customary supply ditch in earth and the border gate are supplanted by a pipe with its top about 2 feet below the ground surface, from which branches a short length of smaller pipe terminating in a standpipe in which a metal valve is inserted. The concrete standpipe valve and hood are shown in figure 9. Portable hydrants

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[4] Bulletin 280 of the California Experiment Station on the economical irrigation of alfalfa in Sacramento Valley.

(fig. 10) are taking the place of the hoods. The valves are installed at the upper end of border levees at distances 100 feet apart, making it possible to irrigate two strips from one valve. Where the strips are 25 feet wide, short lengths of pipe are connected to the portable hydrant, which is placed over and attached to a valve, and four strips are watered therefrom. In this way the cost of valves is materially reduced.

In 1917, S. H. Beckett, irrigation engineer of the Bureau of Public Roads, made an examination of the Byron-Bethany irrigation project on the west side of the San Joaquin Valley to outline a suitable method of irrigating alfalfa. Part of the soil of this tract contains a large amount of silt mixed with clay, which it is difficult to moisten to the required depth, and Mr. Beckett had this kind of soil in mind as well as the lighter silty loams in offering the following suggestions:

(1) Wherever the natural contour of the land permits, the border system of leveling should be used. The maximum length of these border strips should not exceed 1,000 feet on the silty clay loam and silty clay soils, and 660 feet on the lighter silty loams.

On the heavier soils the width of checks should not exceed 40 feet. A maximum width of 50 feet may be used on the light soils.

These maximum widths are selected for the following reasons: In the heavier soils, which absorb water more slowly, small irrigation heads must be used. If the border strips on these soils exceed a width of 40 feet with the small heads it is extremely difficult to get an even spread of water over the entire width of border strips. On the lighter soils it is assumed that the irrigation head may be increased, permitting the use of the wider strip.

In the preparation of these lands for irrigation, the grade or slope of the border strip is by far the most important factor. To reduce the rate of flow of water over the land to a minimum and to permit a reasonable penetration of moisture into the soils, the heavy grades within the strips must be eliminated. On the heavier soils this grade may range from 1 to 3.5 inches per 100 feet, while on the lighter types 6 inches per 100 feet should not be exceeded, the most desirable grade being about 3.5 inches per 100 feet. Here it is well to understand that the movement of water over the borders is affected by the thickness of the stand of alfalfa as well as the length of the period between cutting and irrigation. A 100 per cent stand is one of the most effective means of getting an even spread of water over the land.

Too much emphasis can not be placed on this question of grades, for it is impossible to obtain satisfactory results in the irrigation of heavy soils on grades of 6 inches or more per 100 feet, especially if the border strips are not level from side to side and if the stand of alfalfa is poor.

(2) Wherever the contour of the land will not permit these grades to be used, contour borders may well be substituted, in which any desired grade may be maintained. The average width of these border strips will depend upon the contour interval between the levees. On the heavier soils this interval should be reduced, thus narrowing the average width of the strip.

(3) Irrespective of the type of border strips used, the land within the strips should always be carefully leveled. The standard practice is always to level the strip so that not more than 0.1 foot difference in elevation is to be found

in its width. This insures an even spread of water over the entire soil surface. On heavy fills allowance must also be made for settling; this avoids the formation of pot holes and prevents scalding of the alfalfa.

(4) On all types of border strips on heavy soils surface drainage must be provided for. This means the construction of "open-ended" strips. In this construction the most common practice is to extend the levees to within 10 to 20 feet of the lower end of the borders, thus allowing the excess water to pass off along the lower ends of the strips, where it may be collected and redistributed on the next tier of strips. Occasionally the border strips are drained through boxes into ditches serving the lower area, although this method is not extensively used. The object of drainage is to prevent scalding of the alfalfa, due to submergence for a long period during the hot summer days.

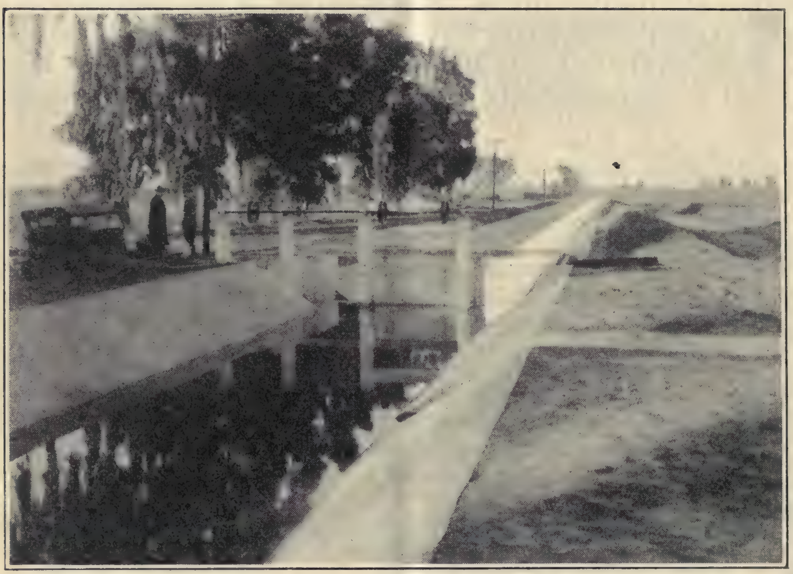

FIG. 29.—Concrete lined lateral with automatic check gate and drop on Turlock Irrigation District, California.

(5) The types of border strips recommended above call for small heads of water. On the heavier soils the head will not exceed 2 cubic feet per second for each acre contained within the strip, with fractional acreages in proportion to this amount. As an example a strip 660 feet long and 40 feet wide contains approximately 0.6 acre. The maximum flow turned into it, therefore, should not exceed 1.25 cubic feet per second. Under field conditions the irrigator soon learns how the various portions of his field take water, and a uniform irrigation then becomes a matter of judgment in splitting the irrigation head to obtain the best results.

(6) The size of the levees to be built depends on the size of the irrigation head used, the effect of harvesting machinery in wearing down the levees, and finally on whether the field is to be pastured.

On a straight border system the settled levee in these soils should have a height of at least 6 inches and a base width of at least 5 feet. Under severe wear of farm machinery in crossing the levees at an angle or where the area is to be pastured the size of the levees should be materially increased, the minimum settled height being at least 8 or 9 inches, with a base width of about 6 feet.

(7) Although in the above discussion very definite suggestions have been made, the best designed system possible may be a complete failure, owing to improper handling of the water and poor judgment on the part of the irrigator. With abuse rather than use, any irrigation system may easily become a burden to the community in which it is located.

The Modesto and Turlock irrigation districts of the San Joaquin Valley, although organized in the late eighties, used little water until 1902. The structures which formed part of the original systems were of wood, but these are being gradually replaced by more permanent material. Figure 29 shows a portion of one of the distributing canals of the Turlock district lined with concrete in which is inserted an automatic check gate and drop. A turnout from one of these lined canals, consisting of two or more joints of concrete pipe projecting out of a concrete box, the opening of which is controlled by wooden flash boards, is shown in figure 30. Another turnout consisting of concrete walls, a concrete pipe, and metal gate is shown in figure 31.

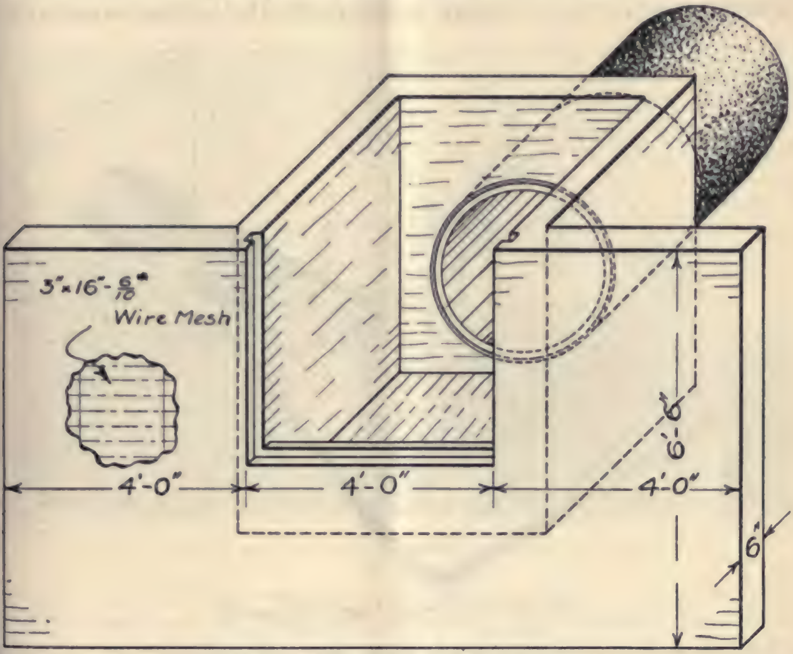

FIG. 30.—A farmer's turnout from lateral.

In the southern end of the San Joaquin Valley, at Wasco, Calif., a large tract is being prepared for border irrigation. This tract was prepared for irrigation about 25 years ago, by dividing it into large contour checks, a method then commonly practiced in that part of the State. These being unsuited to modern requirements, the heavy levees are being leveled and border strips 33 to 40 feet wide and 660 feet long formed instead. In this work of transformation the tract was divided into fields to conform to the topography of the land, a contour survey made, and ditches located, extending west as well as north and south from the several pumping plants. These ditches have a grade of about 2 feet per 100 feet, with a freeboard of 5 feet, and are elevated far enough above the graded surface to permit water to a depth of 5 to 7 inches to flow over the land. After the tract was roughly leveled by a wooden float or drag drawn by a tractor, as shown in figure 32, the borders were staked off and marked by a reversible disc, without stagger. The borders were made by using first a 2-mule plow, followed by a 4-mule disk. After the borders are made, the space between each pair is leveled. The appearance of the borders and intervening spaces at this stage is shown in figure 33.

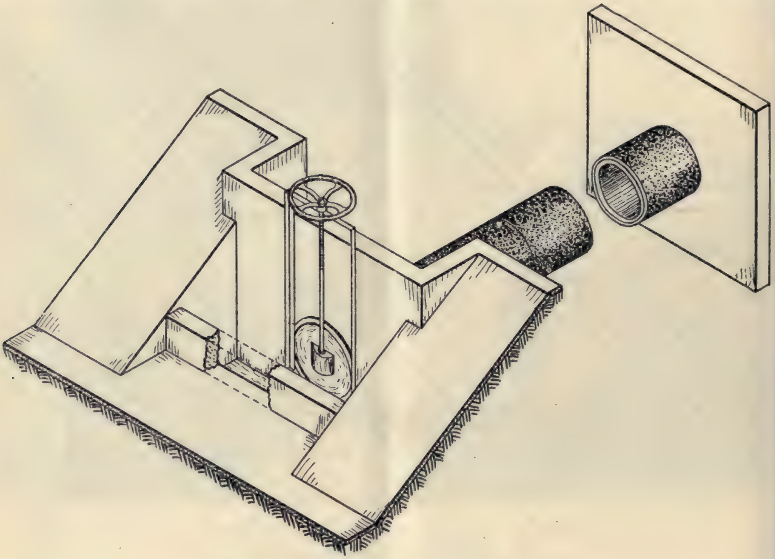

FIG. 31.—A turnout from main lateral.

In the Imperial Valley, for all crops that are irrigated by flooding, the border method is by far the most common. At first the border strips were made too long and too wide and little was done to adapt the size of border and the head of water used to the soil type. In more recent years many of the long border strips on porous soils have been shortened by building additional head ditches, and the heads of water on compact soils have been reduced, to allow a deeper penetration of moisture. These and other modifications of former practices are recommended by Packard[5] as a result of investigations carried on from 1914 to 1917 in cooperation with the Bureau of Public Roads. The following paragraphs are extracted from Mr. Packard's bulletin:

METHOD OF IRRIGATION RECOMMENDED FOR POROUS SOILS.

The great danger in all sandy or porous soils is that too much water will be applied and a high-water table thus formed. This condition is already prevalent in some sections, where sand overlies clay. The clay tends to retard the downward movement of the water, and as a result there is an accumulation of water above this stratum, which gradually rises toward the surface as irrigation continues. This rise of water table can be prevented in a majority of cases by adopting one or all of the following suggestions.

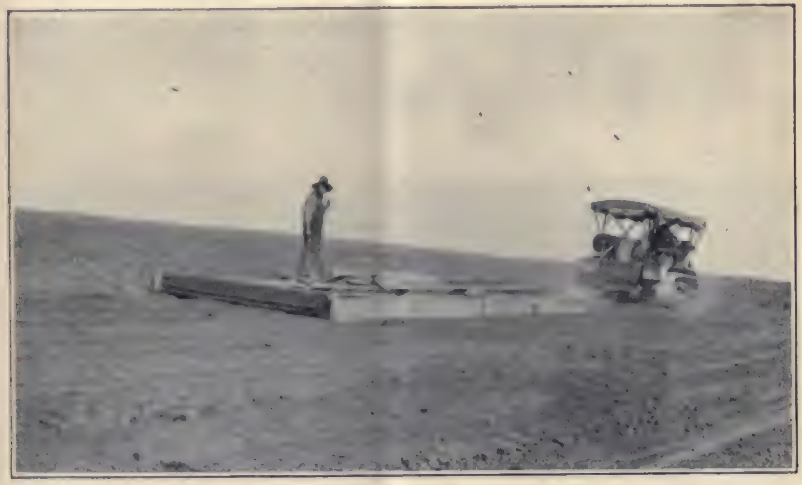

FIG. 32.—Rough levelling land for border irrigation near Wasco, Calif.

The border strips for irrigation on this type of soil should usually not exceed one-eighth of a mile in length and, if necessary, not more than 25 to 30 feet in width in order that the water applied may reach the lower end without oversaturating the upper end. There are many fields in the valley where water has been run from a quarter to a half mile on these types of soil, with the inevitable effect of adding too much water at the upper portion of the field, which, of course, results in a rise of water table. The exact length and width of the lands must depend on the condition of the surface and the degree of porosity of the soil. If the soil is very sandy the strips should be both narrow and short in order to allow a quick irrigation.

In addition to using smaller strips than are now being used, it would be an advantage in nearly all cases to use much larger heads of water than are at present used on this type of soil. A small head will often disappear so rapidly at the upper end that it takes a very long time to cover the field. The size of head must conform to the size of the strip and the character of the soil, the point being to run the water so quickly over the land that an excess above the requirements of the plants will not be added to any part of it. A head of 3 to 8 cubic feet per second for the very sandy soil and from 2 to 4 cubic feet per second for the more compact sandy loams would not be too great. A soil auger can be very effectively used in determining the soil-moisture condition where one is uncertain regarding the moisture penetration.

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[5] Bulletin No. 284, University of California, "Irrigation of Alfalfa in Imperial Valley," by W. E. Packard.

METHOD OF IRRIGATION RECOMMENDED FOR MEDIUM SOILS.

The sandy loam soils are easily irrigated, although too much or too little water is sometimes applied, with the usual results. There is no good excuse, however, for not having a good moisture condition in these medium soft soils. If the alfalfa does not grow as rapidly as desired, an investigation should be made of the moisture condition in the soil by the use of a soil auger or a spade. If the top soil appears too dry before irrigation it would perhaps be wise to give the field an additional light irrigation between cuttings.

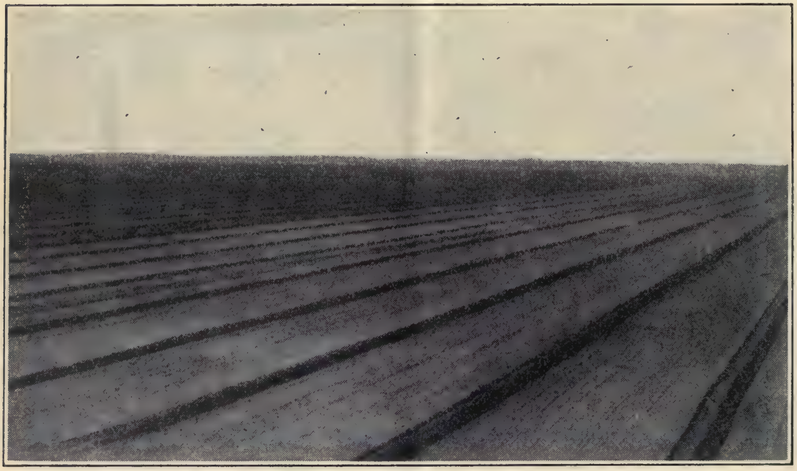


FIG. 33.—Newly made borders on the Hoover farm near Wasco, Calif.

METHOD OF IRRIGATION RECOMMENDED FOR COMPACT SOILS.

The problem on the hard type of soils is to get the water deep into the soil in sufficient quantities to maintain rapid growth.

In many cases the fact that the surface has been irrigated is taken as evidence that the water has soaked in, while in reality only the top 6 inches have been wetted. It is very common to find dry soil at a depth of 2½ to 3 feet in these heavy soils. In order to get proper penetration, the following recommendations should be followed out.

The border strip should be from an eighth to a quarter mile long, very seldom running one-half mile, as is now a common practice. It is difficult to handle water properly on long strips, as a flooding of the lower end can seldom be avoided. On land that is comparatively flat, borders 50 to 100 feet apart are satisfactory, but when the land is at all steep, strips should be narrowed down to 25 to 30 feet wide, so that a small head will cover the surface evenly.

In order to get proper penetration it is necessary to run a comparatively small head for a long time. Fields which yielded from 2½ to 3 tons per acre per year have been made to double the yield through this system of irrigation.

A small head of water requires a much longer time to travel over the field than a larger head and allows of a better penetration. Land which could be wetted only to a depth of 3 feet when large heads were used were successfully wetted to a depth of 5 and 6 feet by the use of smaller heads. The effect of smaller heads running for a longer time is more noticeable with furrow irrigation than with flooding, but the effect is marked in both cases.

Formerly, wooden border gates were used throughout in the Imperial Valley, but owing to unfavorable climatic conditions the wood, when in contact with earth, soon decayed, and structures of more permanent materials have taken their place. The border gate now very generally installed is shown in figure 34. It consists of a joint of concrete pipe, usually 12 inches in diameter, to which is precast a bulkhead of the same material. The gate proper is made of galvanized iron which fits into grooves in the bulkhead, and at the bottom of each groove is an opening for the removal of sand and silt. The capacity of a 12-inch gate is about 3 second-feet, when laid so that the center of the pipe is on a level with the ground surface. One or two extra joints of pipe are used with each gate.

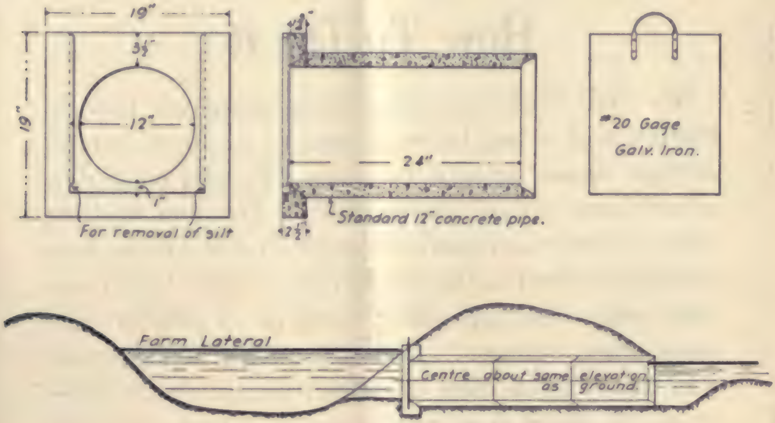


FIG. 34.—Imperial Valley border gate.

How To Do It

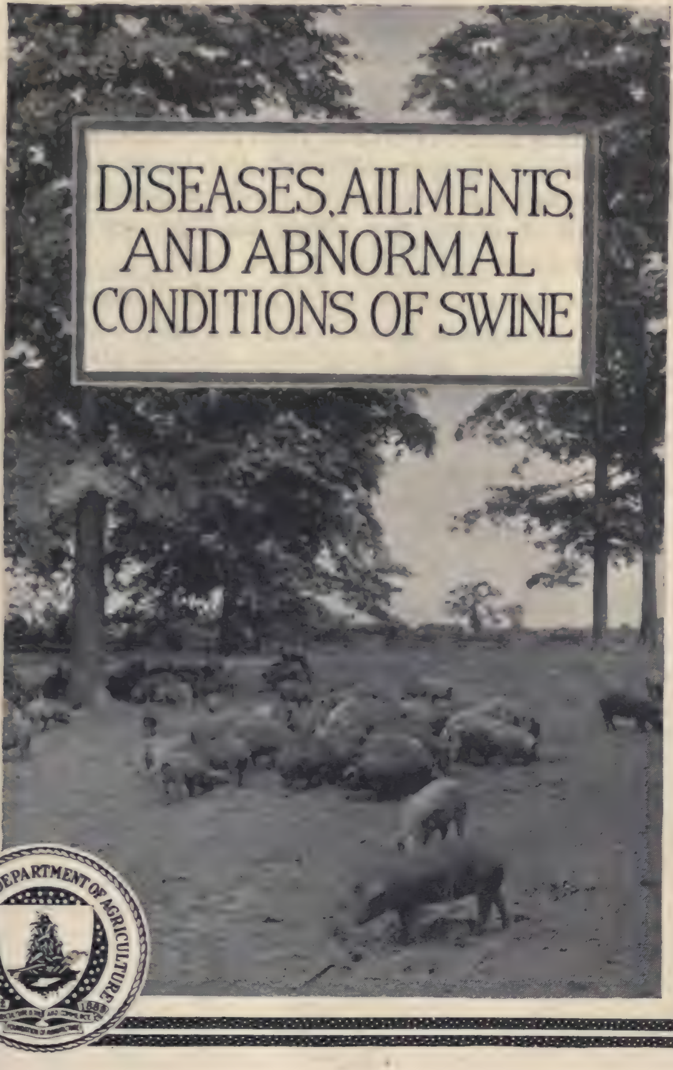
DO YOU WANT practical suggestions on how to build a silo, a hog house, a poultry house, a potato-storage house, or how to make a fireless cooker or other farm home convenience? Are you seeking ideas on how to prepare vegetables for the table, how to care for food in the home, how to bake bread and cake and other appetizing foods in an efficient and economical manner? Is there some practical question about your corn or wheat or cotton or other crops, or about your poultry or live stock, to which you are seeking an answer? The answers to thousands of such questions and practical suggestions for doing thousands of things about the farm and home are contained in over 500 Farmers' Bulletins, which can be obtained upon application to the Division of Publications, United States Department of Agriculture, Washington, D. C.

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1922

U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1244

DISEASES, AILMENTS, AND ABNORMAL CONDITIONS OF SWINE



IN MANY SECTIONS of the swine-raising States it is still customary, although a violation of the law, to attempt the shipping of diseased hogs to market instead of giving the ailing herd proper attention and treatment.

In numerous cases such hogs are affected with some contagious disease and not only succumb in shipment but spread the infection to others with disastrous results.

It would be much safer for the livestock industry in general, although, perhaps, less profitable to the owner, to hold sick hogs on the farm till they have received proper treatment and are fully recovered.

Federal and State regulations are intended to prohibit the moving of diseased swine from one point to another, and do much toward reducing the number of dead hogs reaching the market, and to lessen the dissemination of swine diseases.

Washington, D. C. **Issued June, 1923**

DISEASES, AILMENTS, AND ABNORMAL CONDITIONS OF SWINE.

By T. P. White,

Assistant Chief, Division of Hog-Cholera Control, Bureau of Animal Industry.

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IMPORTANT INFECTIOUS DISEASES.

DISEASES AND CONDITIONS RESEMBLING HOG CHOLERA.

WITH THE DIMINUTION of hog cholera, the attention of farmers and swine breeders is called to more or less serious ailments of swine which, in time of unusual prevalence of hog cholera, go unnoticed or possibly are diagnosed as cholera itself. The group includes anthrax, epilepsy, gastroenteritis, necrobacillosis, pleurisy, pneumonia, poisoning, swine plague (hemorrhagic septicemia), tuberculosis, and worms. Other diseases not similar in appearance to hog cholera are either not recognized or are not deemed of sufficient importance to require attention. Any deviation from the normal in the functions of an animal, such as gait, appetite, or digestion, deserves the closest watching in order that measures may be taken to prevent serious results and possible losses. While some minor ailments of swine might be treated successfully by the owners, it is always well, in case of doubt, to call for more experienced service.

The owner of hogs is interested in having his herd free from disease. The healthier the animals the quicker they will finish for market. In a large number of cases sickness and unthriftiness are due, directly or indirectly, to improper care in housing, feeding, and at farrowing time. Even under the best conditions hogs are liable to sicken, and in all circumstances of that character there is need of correct diagnosis in order that effective treatment may be given. Many factors are to be considered in distinguishing between hog cholera and the various other ailments and conditions that resemble that disease.

HOG CHOLERA.

Hog cholera is still the most serious of swine diseases. For many years the swine industry has been hampered and retarded in growth by the ravages of the disease and in some sections entire herds were destroyed. The reappearance of cholera year after year, with practically no known methods of protection, lent a discouraging aspect to the raising of swine. The losses in a single year from cholera have been computed as high as $73,000,000, and for many years it was estimated at $40,000,000 annually.

Though years have been spent in the study of hog cholera there are yet many factors responsible for the spread of the infection that are not known or fully understood. As a result of experiments a serum was developed by the United States Department of Agriculture which protects hogs against cholera. The general adoption and use of this immunizing agent have created a feeling of security among swine growers and the result has been an increase in the production of hogs. Incidentally, it has stimulated the raising of cattle, since this phase of farming can be engaged in on a more profitable basis by having healthy herds of hogs follow the cattle.

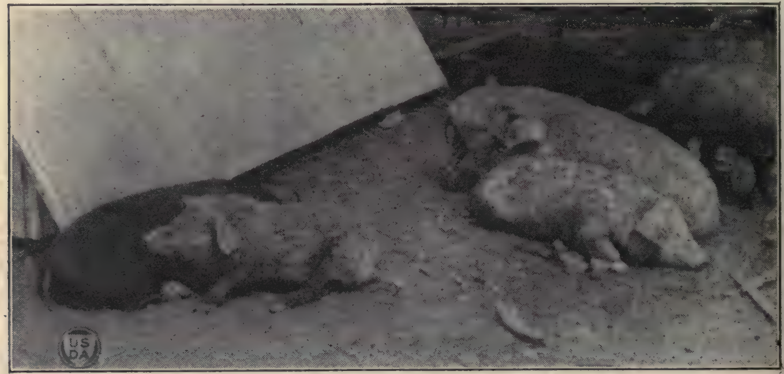

FIG. 1.—Pigs in advanced stage of hog cholera.

Although losses from hog cholera have been reduced over 60 per cent from the peak years of destruction, the lack of attention on the part of farmers in the proper care of swine herds still occasions a serious monetary loss each year to the swine industry as a whole.

Symptoms.—Hog cholera is characterized by complete loss of appetite, extremely high temperature, constipation usually followed by diarrhea, chills, depression, burrowing in litter, ears and tail drooping, and sometimes cough. (See Fig. 1.) Red spots or blotches appear on the skin of the belly, inner side of the hams, and on the ears. In the advanced stages there is a staggering gait, and a gummy discharge from the eyelids often glues the eyes shut. All of these symptoms, however, may not appear in each individual hog affected.

Lesions.—On autopsy some or all of the following lesions may be noted: Hemorrhages (small, dark-red spots) showing through the capsule of the kidneys, bright-red blotches on the surface of the lungs and the outer covering of the intestines. The lymphatic glands are congested and enlarged, those most easily observed being located at the angle of the lower jaw, in the flanks, and in the fat of the intestines. Small, red blotches may be also found on the inner lining of the bladder and on the heart. In the advanced or chronic stage large buttonlike ulcers may be seen on the mucous membrane (inner lining) of the large intestines near the point where the large and small intestines join.

Treatment and prevention.—There is no reliable treatment for a hog visibly sick with hog cholera. Owing to the sudden onset and the rapid spread of the disease, swine herds should be constantly protected against the danger of infection. Cleanliness in the hog lot, the pen, and the shelter is absolutely necessary for the welfare of the herd. Proper housing (as in Fig. 2), disinfection of quarters from time to time, keeping the animals within well-fenced lots to protect against infection carriers, and care in feeding will do much toward keeping the herd free from disease. In case a herd is attacked by cholera prompt attention is essential to prevent heavy losses. The serum treatment should be administered as soon as the disease is recognized or preferably when there is reason to suspect that the animals have been exposed to the infection. If any of the hogs have died, the carcasses should be burned or buried. After the sick ones have recovered and no further spread of the disease is noted, all quarters to which the animals have had access should be cleaned and disinfected.

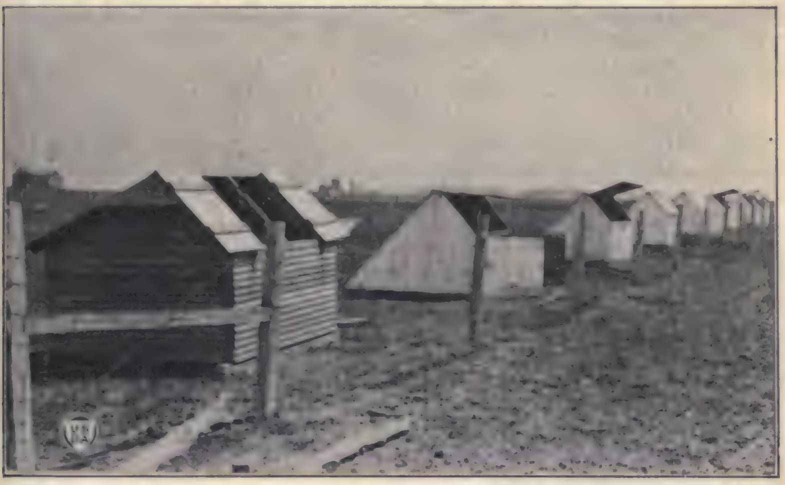

FIG. 2.—Good type of individual hog houses.

The serum treatment for hog cholera is primarily an immunizing agent against the disease, though when used in the early stages it seems, in some cases, to have a curative effect. Many laymen are attempting to treat hogs for cholera without being able to recognize one swine disease from another. Many minor ailments are often mistaken for cholera, and serum is used when cholera is not present, ending in bad results and the waste of the serum. If cholera is suspected, it is always best to call a trained veterinarian.

For further details concerning this disease and its prevention see Farmers' Bulletin 834, Hog Cholera.

SWINE PLAGUE (Hemorrhagic Septicemia).

Swine plague is essentially a type of swine pneumonia, but is not a herd disease. It attacks individuals only, in the herd as a rule. It is now generally agreed that swine plague and hemorrhagic septicemia in swine are the same.

Cause.—Swine plague is caused by a specific organism, *Pasteurella suiseptica*. This germ is found in the respiratory tract of many healthy hogs, but is apparently harmless until the vitality of the hog is lowered through disease or other factors. This accounts, perhaps, for the fact that swine plague is often found in connection with hog cholera. The devitalizing effects of cholera on the animal create a condition under which the disease organism becomes active resulting in the developing of swine plague. In such cases it is practically impossible to differentiate between the two diseases. Even with a post-mortem examination it is quite difficult to establish a line of demarcation between hog cholera and swine plague when occurring in the same animal at the same time.

Treatment.—When swine plague appears as a complication of hog cholera the case should be handled and treated as one of hog cholera, as the latter disease is by far the more fatal. The treatment for an uncomplicated case of swine plague is largely hygienic. Remove the sick hogs to comfortable, dry, clean quarters, provide plenty of fresh air and clean drinking water. Restrict the feed for a few days.

Hemorrhagic septicemia bacterins and hemorrhagic septicemia serums are on the market and have been used more or less extensively, but the treatment of this disease with such products is still in the experimental stage.

TUBERCULOSIS.

Tuberculosis is an infectious disease common to both domestic animals and man. It is slow in its development and is hard to recognize until the later stages, except through the application of the tuberculin test. In hogs tuberculosis is not likely to be mistaken for hog cholera unless the disease (tuberculosis) has progressed to an advanced stage.

Symptoms.—Tuberculosis, though it may have existed in a herd for a considerable period, is difficult to detect by clinical examination. There is rarely any elevation of temperature. The appetite, as a rule, is not impaired in the early stages of the disease. Later, however, the hogs affected lose their appetite, and this, coupled with the wasting nature of the disease, causes the animals to become weak and emaciated. If the lungs are involved, there is frequent coughing while lesions of the intestines may produce more or less diarrhea. In advanced cases the temperature is sometimes below normal, and the ailment then somewhat resembles chronic hog cholera. However, there is no congestion of the visible mucous membranes and no gummy exudate from the eyelids. While the animals are slow in moving about, there is not the staggering gait seen in chronic cholera.

Autopsy.—On examination of the dead animal there will be found in the lungs whitish-gray nodules varying in size from a pea to a walnut, and even larger. These nodules have a yellowish cheeselike center. Similar lesions may also appear in the liver and the spleen (melt). Sometimes these nodules may consist of a fibrinous material and contain a cheesy or granular substance. The lymphatic glands of the body, especially those located at the angle of the lower jaw, those between the lungs, and those in the fat of the intestines, are usually involved. Tuberculosis causes the inner portion of these glands to turn to a cheesy consistency, yellowish-white in color, which in the advanced stage of the disease may assume a gritty condition somewhat resembling grains of sand, very noticeable when cutting through them with a knife. In generalized cases of tuberculosis the lungs may be filled with multiple tuberculous abscesses and those organs may adhere to the ribs. The multiple abscesses are sometimes seen covering the entire pleura on one or both sides.

The extent of tuberculosis among swine in the United States is indicated in the annual reports of the Bureau of Animal Industry, United States Department of Agriculture. During a seven-year period, beginning in 1914, there were found at slaughtering establishments where Federal inspection was maintained over 3,500,000, or an average of 500,000 hogs each year affected with tuberculosis. These hogs were shipped from practically all parts of the country, and show that there are but few sections free from the disease.

Treatment.—Prevention is the main thought in the fight against tuberculosis. Since hogs usually contract the disease through feeding on skim milk from tuberculous cows or in following tuberculous cattle in the feed lot, there is no better preventive measure than to have a tuberculous-free herd of cattle. All skim milk fed should be heated sufficiently (145° F. for 30 minutes) to kill the germs of tuberculosis.

The tuberculin test is being used successfully in detecting tuberculosis in swine, the intradermic test being preferable. The reactors should be segregated and handled according to official agreement, if such exists. If the animals are marketed for slaughter, they should be shipped under proper regulations to a slaughterhouse where slaughtering is done under the supervision of Federal inspectors. Hogs known to be affected with tuberculosis should not be sold to local butchers.

HOG "FLU" (Swine Influenza, Infectious Bronchitis).

Hog "flu" or swine influenza, sometimes referred to as infectious bronchitis, is a disease of swine which appears widespread, particularly in sections where hogs are raised in large numbers. It is a herd disease attacking a large per cent of the animals at the same time. The thrifty, growing hogs seem to be more susceptible than the poorly fed and unthrifty ones.

Cause.—The causative agent of flu is unknown. While a sudden change of feed, such as from pasture to a heavy ration rich in protein, has been attributed as a factor, a study of the disease has failed to substantiate this theory.

Symptoms.—Swine flue is characterized by the sudden prostration of a large portion of the herd. There is complete loss of appetite. Spasmodic breathing, or thumps, is one of the first symptoms noted. When urged to move, the animals have violent fits of coughing. The eyes are red, swollen, and weeping. There may be a discharge from the nose, often streaked with blood. Occasionally a hog will vomit stringy mucus tinged with bile. The temperature in typical outbreaks ranges from 104° F. to 108° F. and usually drops to 103° F. to 104° F. in about a week, when, if the hogs survive, they are usually back on feed.

Treatment.—The treatment for swine flu is almost entirely hygienic. Place the animals in warm, clean, well-bedded quarters, with plenty of fresh air, and provide plenty of fresh drinking water. Give little feed or none at all for 24 hours.

INFECTIOUS ARTHRITIS (Joint Ill, Navel Ill).

Cause.—Infectious arthritis is an ailment resulting from filthy, damp hog lots and insanitary pens and shelters. Germs gain entrance to the body through the tender navel soon after birth. The infection reaches the joints and seems to center in these locations.

Symptoms.—The symptoms noted are disinclination to suckle, constipation, dullness, and lameness. Examination of the navel will reveal the seat of inflammation and sometimes an abscess. The joints are found to be hot, tender, and swollen. Weakness and emaciation follow and the affected pigs usually die from septic absorption.

Treatment.—While infectious arthritis is not seen as frequently in pigs as in calves and foals, it is, nevertheless, a good precaution to examine young pigs very closely for a few days following birth, or until the navel cord has dried and fallen off. If inflammation is noted the navel should be washed with warm water to which a small amount of cresol has been added, and then a dry dusting powder of starch or alum applied. Each pig should be given a physic of Epsom salt and kept in a dry, warm place. If Epsom salt is not available, a dose of raw linseed oil may be given.

ANTHRAX.

Anthrax is an infectious disease of domestic animals which attacks cattle and sheep particularly. Hogs are less susceptible to anthrax, though in a few cases they have been known to contract the disease.

Cause.—Anthrax is caused by a specific microscopic organism known as the anthrax bacillus. This organism lives in damp soil, and fields containing stagnant pools in which the disease has existed may be the source of infection.

Symptoms.—The symptoms of anthrax appear suddenly and quite often the animals are found dead before anything wrong has been observed. When the disease is noted in the living animal there is a high temperature, a complete loss of appetite, chills, and muscular tremblings. The breathing is labored. Blood escapes from the vessels, and the throat becomes swollen and filled with bloody froth.

Red blotches may be seen under the skin as well as in the internal organs after death.

Treatment.—A vaccine is now available and generally used as an immunizing agent against anthrax, and in some instances it has been used as a curative with some degree of success. The organism of anthrax is very hard to destroy by the usual means of disinfection and the burning of carcasses of animals that die of the disease is very important. It is equally as important that the quarters to which the sick ones have had access be thoroughly disinfected. Anthrax is transmissible to man and extreme care should be exercised when handling diseased carcasses. Outbreaks of the disease should be reported promptly to the proper State authorities and their advice followed in the suppression of the malady.

LESSER DISEASES, AILMENTS, AND CONDITIONS.

ABORTION.

Abortion is the expulsion of the developing embryo from the uterus before the end of the gestation period.

Cause.—Abortion may be brought about through exposure to severe cold weather, injuries, crowding, or rough handling. It may occur as a result of poisoning and as a sequel of and in the course of an infectious disease. Infectious abortion is caused by a specific organism which invades the genital organs. This type of the disease is discussed in Farmers' Bulletin 790, Contagious Abortion of Cattle.

Symptoms.—The symptoms of pending abortion vary according to the period the animal has been pregnant. In the advanced stage of gestation the sow in which abortion is threatened goes off feed, is restless, shivers, has muscular tremblings, and at times may experience labor pains. Bleeding from the genitals may occur, although this is not a constant symptom. After a time the delivery of dead pigs will come about. It is quite common in aborting sows to have a discharge from the uterus resulting from infection.

Treatment.—Proper care of pregnant sows will do much to eliminate the danger of abortion. Pregnant animals should be protected from injuries and exposure to bad weather. They should have plenty of exercise and not be placed in crowded pens or shelters. Feeding has much to do with the general health of the pregnant sow, which in turn has a decided influence on gestation. When signs of abortion are noted the sow should at once be taken away from the rest of the herd and placed in a clean, comfortable shelter, preferably a box stall. If the pigs are dead and can not be expelled in the natural way they should be removed with instruments, care being taken also to remove all of the afterbirth from the uterus. The parts should be washed out with a warm normal salt solution. The diet should consist of soft liquid rations, such as mashes, milk, and clean slops. A dose of calomel may be given to keep the liver active. If there is a discharge from the uterus of the aborting sow, douching with permanganate of potash, 1 ounce to the gallon of water, or a 2 per cent solution of lysol, repeated once a day, usually proves very beneficial. It is always well to consult a veterinarian.

CHOKE (Obstruction of the Gullet).

Cause.—Obstruction of the gullet in hogs is commonly caused by the animal attempting to swallow a piece of potato, apple, turnip, or other hard feed before it is sufficiently chewed. In some cases the obstruction may be partial and allow the passage of liquid but not solid feed, while in others there is a complete obstruction.

Symptoms.—A choke is easily recognized by the fact of its sudden appearance. The hog suddenly stops eating, stands with outstretched head and neck, nose held close to the ground, mouth open, and saliva flowing freely. If the obstruction is complete a considerable amount of fluid may find its way into the air passages and occasion coughing spells. The animal gasps and sometimes makes efforts to vomit.

Treatment.—Examination does not reveal the location of the object so readily in the hog as in the cow or the horse, owing to the large amount of fatty tissue around the throat. The condition is more difficult to treat in the hog than in other animals. It is rather dangerous to drench a hog, and to use a probang is equally so, unless one has a thorough knowledge of the back of the mouth opening into the esophagus (gullet). If the choke is in the upper portion of the gullet, the material may be reached and removed with the fingers or with long forceps or pinchers. If located lower, the administration of oil may be attempted and prove successful, as it may work around the mass and soften it sufficiently to permit it to be swallowed, or having lubricated the esophagus, it may assist in the expulsion of the object in the act of coughing or vomiting. The condition is serious enough to require trained service.

DIARRHEA IN PIGS (Scours).

"Scours" is a very serious ailment of pigs which takes a heavy toll each year from the new litters. In many of the swine-raising States of the Middle West, where as a rule spring is a rainy and backward season, scours is rated next to hog cholera in the destruction of pigs, and causes severe losses to the industry.

Causes.—Scours is a condition resulting from improper care of both the sow and the litter, and may appear in pigs at an age varying from one day to several weeks. When the disease attacks a pig a day or two old it is evident that some element of faulty nutrition in the mother is a responsible factor. Where the pigs are kept in damp, insanitary quarters, deprived of sunshine and exercise, or allowed to be out and exposed to cold, rainy weather and become chilled, it is no wonder the litter becomes a victim of diarrhea.

Symptoms.—The chief symptom, of course, is the profuse diarrhea. The discharge from the bowels is of a thin fluidlike character grayish-yellow in color, and of a very foul odor. At first the appetite is not badly impaired, but in a few days the pigs affected stop eating or nursing and they soon begin to lose strength and flesh. The coat becomes rough and scurfy and the little pig squeals with pain when handled.

Treatment.—If the scours sets in when the pig is but a few days old the ailment is nearly always fatal. Proper attention should be given to the feeding of the sow both before and after parturition so that nothing of an irritating nature is transmitted through the milk to the offspring. The nursing sow should be kept in a clean, warm, comfortable pen or shelter where with her litter she will have plenty of room, air, and sunshine. The pigs should receive each a dose of Epsom salt as a physic to clean out whatever irritating substance there is in the bowels. If the diarrhea persists the physic may be followed with half-dram doses of subnitrate of bismuth. In the absence of Epsom salt raw linseed oil may be substituted.

GASTROENTERITIS (Inflammation of the Stomach and Bowels).

Inflammation of the stomach and bowels is discussed under one heading, as in nearly all cases the condition involves both of these digestive organs.

Cause.—As a rule, gastroenteritis is the result of improper feeding. It may result from the action of irritating substances, such as lye, washing compounds, and sometimes glass, in garbage. Drinking of brine or eating too much salt, as well as many forms of poisoning, may bring about the condition. Excessive or prolonged feeding on a certain diet, such as green corn, frozen forage or silage, moldy feed, or drinking cold water while in a highly heated state—any of these factors may induce gastroenteritis.

Symptoms.—Gastroenteritis is more common in growing pigs and shotes than in older hogs, and the symptoms may easily be confused with those of hog cholera. Owing to the severe pain, the animals stand with arched backs and tucked-up flanks. There is suppression of appetite. Particularly in pigs, there is a thin, fluid-like diarrhea. If pressure is applied to the belly the animals show evidence of pain. There is a slight rise of temperature, accompanied with thirst. As the ailment continues there is pronounced weakness and a staggering gait.

Treatment.—If proper care and attention are given to feeding, the extent of gastroenteritis in hogs will greatly diminish. First of all the diet must be corrected, and whatever irritating substance there is in the digestive tract must be eliminated. A dose of Epsom salt, or of raw linseed oil, varying from 1 to 6 ounces according to the size of the animal, should be given. Avoid heavy feeding for several days, giving thin bran mashes, barley gruel, and milk. The animals should be brought back to the normal ration gradually. If the diarrhea persists, intestinal antiseptics are indicated, such as the sulphocarbolates. Give a plentiful supply of clean drinking water.

ICTERUS (Jaundice).

Cause.—Icterus, or jaundice, is an abnormal condition due to some obstruction of the bile ducts in the liver, and instead of the bile flowing into the intestines normally, it is absorbed through the blood circulation.

Symptoms.—There is general depression, impaired appetite, and sometimes efforts at vomiting. The visible mucous membranes, particularly of the eyes, as well as the white portion of those organs, are of a yellow color. On autopsy the fatty tissue of the body will also be found discolored in the same way.

Treatment.—Since the condition usually arises from a digestive disorder or heavy infestation of internal parasites migrating into the bile ducts of the liver, attempts should be made to correct the diet and to rid the animals of worms. A physic of Epsom salt should be given and the animals placed on a sloppy bran-mash ration for a few days. If the condition does not clear up in a short time a second physic should be given along with 3 to 15 grains of calomel, according to the size of the hog. Keep the animal in dry, comfortable quarters and give plenty of pure drinking water. To rid hogs of worms see directions on page 23.

MAMMITIS (Inflammation of the Mammary Glands, Garget).

Cause.—Mammitis, or garget, is of common occurrence in the sow, owing to the conformation of the animal which allows the udder to hang close to the ground, thus subjecting it to frequent bruises. Under such conditions infection finds its way easily into the tissues through abrasions, sometimes reaching the inner substance of the glands through the opening in the teats. There is a resulting inflammation, painful swellings, and oftentimes numerous abscesses.

Symptoms.—The symptoms of mammitis are easily recognized by the swollen mammary glands (udder) which are hard and hot to the touch. There is a loss of appetite, and fever and constipation are noted. The sow will often refuse to let the pigs suckle on account of intense pain.

Treatment.—Nursing sows should be kept in clean lots or pastures, where the chances of injury to the udder are lessened. They should be closely observed frequently, and if sore teats are noted immediate attention should be given before the condition becomes serious. If there are signs of inflammation, a dose of Epsom salt is desirable. If there are open sores the affected parts should be cleaned and washed with warm water in which alum has been dissolved. After thorough cleaning, a mixture of 15 parts of glycerin and 1 part of carbolic acid should be applied to the sores. If abscesses of the glands are noted, they should be opened with a clean, sharp knife, drained freely, and a 50 per cent solution of iodin injected into the openings or pockets. Hot applications may be used on the glands (udder) to reduce inflammation and swelling.

METRITIS (Inflammation of the Uterus).

Cause.—Metritis (sometimes called pig-bed fever) may follow either a normal delivery or a case of abortion. Most commonly it follows cases of difficult parturition, where assistance has been given in delivering the pigs. In such instances it often happens that no precautions are taken to prevent the introduction of infection. The instruments used and the hands of the person may be dirty and so be the means of contamination. Sometimes a dead pig or a portion of the afterbirth may be retained in the uterus and cause the inflammation.

Symptoms.—The symptoms are those of chills (shivering), dullness, restlessness, temperature often up to 105° F., and loss of appetite. Sometimes the animal staggers when moving about. The genitals are inflamed and hot to the touch, and if dead pigs are retained there will be frequent efforts made to expel them. There is a foul-smelling discharge from the vagina.

Treatment.—Metritis results in serious losses each year from the fact that it affects the most valuable portion of the herd, the breeding females, and is a condition demanding more attention. When difficult parturition makes it necessary to give assistance in the delivery of pigs care should be taken that the instruments and hands are thoroughly clean before starting in on the case. Great care must be exercised to avoid injury to the organs and to the passages of the region. The uterus should be thoroughly emptied and washed out with a warm salt solution, or a 2 per cent solution of lysol. A solution of permanganate of potash, 1 ounce to the gallon of water, may be used. Cases of this character should have the attention of a veterinarian.

NECROTIC ENTERITIS (Necrobacillosis).

Necrotic enteritis is a chronic inflammation of the intestines which impairs the digestion to a serious degree, stunts the growth of the animal, and often proves fatal.

Cause.—From the fact that *Actinomyces necrophorus* is found in practically all cases of necrotic enteritis, the name necrobacillosis is often applied to the ailment. However, it is not fully known to what extent this organism plays a part in the development of the disease.

Symptoms.—Necrotic enteritis is usually confined to pigs and shotes, rarely affecting the older hogs in the herd, and may show in a number of young animals at the same time. In the early stage the appetite is not badly impaired, but as a rule there is a profuse diarrhea. As the disease progresses the pigs eat sparingly, become pot-bellied, unthrifty, thin, and weak. The skin is dry and scurfy. While these symptoms are somewhat like those of hog cholera, the absence of fever and the fact that no red spots appear in the usual locations on the skin differentiate the ailment from cholera.

Autopsy.—Necrotic enteritis, or necrobacillosis, can easily be recognized by examination of the intestines of a pig that has died from the disease. Small, white, circumscribed necrotic areas may be seen through the outer covering of the large and small intestines. On splitting open the small intestines the inner lining will be found thickened and studded with dead patches ready to slough. These patches contain a mealy or cheesy substance, and in advanced stages the whole membrane can easily be scraped off. The lesions, however, are not elevated and are not confined to a particular section or location, as in hog cholera.

Treatment.—To be effective, treatment should be applied before the disease has progressed. Rough feed and so-called stock food and tonics that may contain irritating ingredients should be avoided. Put the animals affected in pasture if such is available. A physic of some kind, such as Epsom or Glauber salt, or linseed oil, is recommended. The following mixture has been used and found of some benefit as a treatment:

Copper sulphate	1 part.
Hyposulphite of soda	4 parts.
Charcoal	2 parts.
Common salt	6 parts.

Give one heaping teaspoonful of this mixture to every 100 pounds of live weight, in slop or milk, night and morning for about a week.

Care should be taken that the copper sulphate is well pulverized and thoroughly mixed with the other ingredients.

The pulverized copper sulphate alone may be added to the drinking water in proportion of 1 ounce to 25 gallons of water.

NECROTIC RHINITIS (Necrobacillosis, Bullnose, Sniffles).

Necrotic rhinitis is a condition affecting growing pigs principally, and is characterized by an overgrowth of tissues in the region of the face, nose, and mouth, and by a sloughing of certain of these tissues. Necrotic lesions may also occur on other parts of the body.

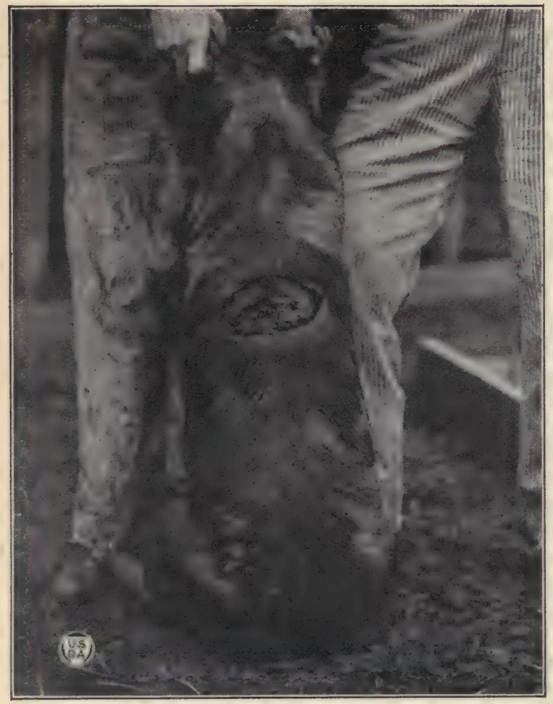

FIG. 3.—Necrotic ulcer (necrobacillosis).

Cause.—Necrotic rhinitis, commonly called necrobacillosis, results from the invasion of the *Actinomyces necrophorus* into wounds or abrasions on the head or other parts of the body, caused by blows with sharp sticks, fighting, and injuring the tissues with the teeth, and laceration of the gums and lips with rough feed or with pieces of bones or wire.

Symptoms and lesions.—Perhaps the first symptom noted is that of impaired appetite. There is repeated sneezing, hence the term "sniffles." A bloody material is often expelled from the nose in the act of sneezing. Well-defined lumps or swellings occur on some part of the head or face, usually on the snout (bullnose). When cut open these swellings are found to contain a cheeselike pus or substance having a disagreeable odor. The lesions extend to and destroy the bones of the face, causing the pigs to assume a "dish-face" appearance.

Treatment.—In this form of necrobacillosis, or necrosis, treatment should be applied in the early stage in order to be effective. When the swellings are noted before they are large they should be incised and all the pus removed, if possible. Then introduce in the openings made a mixture of 15 parts of glycerin and 1 part of carbolic acid or a 50 per cent solution of iodin. After the swellings have become extensive or sloughing of the tissues has set in, treatment is of little avail and destruction of the pig is recommended.

OVERHEATING (Sunstroke—Heat Stroke).

Cause.—Overheating, either as a result of exposure to sun or of extreme exertion, is a common occurrence in swine; in fact, the nature and conformation of that class of animals make them quite susceptible to such a condition. It may easily be mistaken for epilepsy, "blind staggers," or fits if the facts and circumstances in the case are not considered. However, the related factors, such as extremely hot weather, lack of shade, overcrowding, or prolonged chasing of the animals ought to make clear the nature of the ailment.

Symptoms.—Hogs will show signs of overheating rather suddenly. The animals will apparently gasp for breath, grow restless for a few minutes, wabble in their walk, and finally fall over on their sides, going into convulsions. The body temperature is extremly high, in some cases having been known to rise above 110° F. Hogs in overheated condition need prompt attention if they are to be saved from death.

Treatment.—Carelessness on the part of some one, of course, is responsible for the overheating of hogs, for the animals will not remain in the hot rays of the sun or exercise unduly in extremely hot weather unless they are compelled to do so. Swine should be provided with plenty of shade both in the hog lot and in the pasture. In shady fields hogs will do quite well without a wallow hole, but in open pastures with no trees or other protection from the sun, a concrete wallow is almost a necessity. The water in such wallows should be changed often and the bottom and sides cleaned and disinfected at least every two weeks. When an animal shows signs of heat prostration cold water should be poured on the head, but not over the entire body. This should be kept up until the animal shows signs of reviving. Aromatic spirits of ammonia in teaspoonful doses for 100-pound hogs as a diffused stimulant and sweet spirit of niter in half-ounce doses to cool the body temperature are beneficial.

PARALYSIS OF HIND QUARTERS.

Paralysis of the hind quarters in swine is quite common and is attracting considerable attention, since in the majority of cases the cause is obscure and attempted treatment fails to bring relief. Various theories as to the origin of this condition are given, all of which may play a part, but any one of which would be hard to establish in a given case.

Cause.—Paralysis may be brought about by injury in handling, shipping, or breeding. Any lesions that may affect the spinal cord, such as tumors, abscesses, diseased vertebrae, tuberculosis, or parasites, may produce paralysis. A lack of mineral matter in the feed of the growing pig may affect the structure of the bones and cause paralysis of the hind quarters in later life. On rare occasions kidney worms migrating into the muscles of the loin region have been credited with causing posterior paralysis. The paralysis sometimes follows parturition, particularly if the sow is in a run-down condition and is being nursed heavily. Penning up in a small inclosure without exercise for an extended period may cause paralysis. Lumbago and rheumatism also are said to be contributing causes.

Symptoms.—As a rule, paralysis of the hind quarters comes on gradually. The first indication often is a wabbly, unsteady gait, a sort of incoordination of the hind feet. In turning, the animal will move the fore part of the body half around before any attempt is made to move the hind quarters. Walking becomes more and more difficult, weakness of the hind quarters becomes more pronounced, and finally the animal can no longer stand and drags those parts when forced to move about. For a few days there is very little disturbance of the appetite and other functions, but if the condition can not be remedied constipation, loss of appetite, and consequent wasting follow.

Treatment.—Regardless of the cause, the first step in the treatment of posterior paralysis is to make the animal as comfortable as possible. If there is constipation a physic of Epsom salt or linseed oil should be given. Feed a light diet, such as slop made of bran and milk. Keep bedding clean and furnish plenty of pure drinking water. If the sow is suckling a large litter the pigs should be weaned. Massaging of the affected muscles and the application of an irritating liniment are sometimes beneficial. Equal parts of turpentine, ammonia, and linseed oil, mixed, have been used as a liniment with good results. A ration of crushed wheat, bran, and milk, made into a slop, will do much toward restoring the depleted vitality in a sow caused by heavy nursing.

PLEURISY.

Pleurisy is closely allied to pneumonia and is an inflammation of the serous membrane covering the lungs and the inner walls of the thoracic cavity (chest).

Cause.—Like pneumonia, pleurisy is brought about by a number of causes, such as drafty shelters, exposure to cold and wet weather, or injuries by kicks.

Symptoms.—The chief symptoms noted are chills (shivering), rapid breathing, disinclination to move, and loss of appetite. The gait is stilty, the animal affected sometimes showing a marked lameness in the forelegs. Pressure on the chest walls often causes the sick hog to squeal with pain. There is a marked elevation of temperature. The acute form of the disease runs a course of a week or two, but if it becomes chronic it is likely to last several weeks. The quick breathing without apparent movement of the chest muscles, the absence of red spots on the belly and hams, and the fact that the disease does not spread rapidly to the rest of the herd serve to differentiate pleurisy from hog cholera.

Treatment.—As in pneumonia, the treatment for pleurisy should be one of prevention, such as providing warm, comfortable quarters in severe weather, away from drafts, wet floors, and bedding. The same conditions that are conducive to pneumonia are often responsible for pleurisy, particularly the nesting of hogs closely under straw stacks in winter and their coming out into a cold wind for feed and water. The disease is a difficult one to recognize and to treat; therefore no time should be lost in calling in trained assistance, in order that early and proper attention may be given and the loss of animals avoided. Make the hog as comfortable as possible. Apply hot blankets to the chest walls, and give a physic of Epsom salt. A small amount of nitrate of potash, about a half an ounce to the gallon, in the drinking water is beneficial.

PNEUMONIA.

Pneumonia is an inflammation of the lung tissue in which there occurs an excessive outflow of secretion that at times causes clogging up of the air passages.

Cause.—Pneumonia may be induced by a number of causes, such as exposure to severe weather, inhalation of irritating substances, drenching, feeding in dusty lots, lung worms, injury, etc.

Symptoms.—At certain stages of pneumonia hogs or pigs affected act a great deal as if they had hog cholera. There is loss of appetite, disinclination to move about, fast breathing, and increased temperature. These symptoms are shown regardless of the source or cause from which the disease has developed. However, there is much to distinguish pneumonia from hog cholera. Not so many of the animals are sick at one time and the disease does not, as a rule, spread to the entire herd. The temperature of the sick hogs will rarely exceed 104° F., while in hog cholera it may run as high as 107° F. The congested condition of the visible mucous membranes is absent. There are no red spots on the skin covering the inner sides of the hams and on the skin of the belly. Hogs suffering with pneumonia have a tendency to lie on their breasts to get the cooling effect of the ground against the affected parts. Death, as a rule, does not occur so quickly as in hog cholera, recovery is more rapid and complete, and fewer animals succumb.

Autopsy.—Examination of a hog dead from pneumonia will reveal the fact that the lesions are confined principally to the lungs. These organs will be found highly congested and sometimes filled with pus or a puslike substance. At certain stages of pneumonia portions of the lungs assume the appearance of liver, or sections of them will be found in a degenerated (decayed) condition. Signs of cholera in the various organs are absent.

Treatment.—Pneumonia may be prevented by keeping the hogs comfortably sheltered in severe weather, giving them at the same time plenty of ventilation. Burrows in straw stacks are conducive to pneumonia in hogs in winter, as the animals congregate in these hot, unventilated nests and come out to eat or drink usually steaming with heat. In this condition a sudden contact with a cold wind will chill them and often cause them to contract the disease. Hogs should be fed on concrete floors or platforms instead of in mud or dust. (Figs. 4 and 5.) Cleanliness in feeding will do much toward preventing infestation with worms, one type of which migrates from the intestines through the lungs of swine and may cause pneumonia.

The sick hog should be kept in a clean, warm box stall, if possible, where plenty of good air and sunshine are available. Administer a purgative, such as Epsom salt. If the animal will eat, feed bran mashes and other soft and sloppy feed. In severe cases where there is danger of heart failure, 5 to 15 drops of tincture of digitalis may be given every three hours, according to the size of the animal.

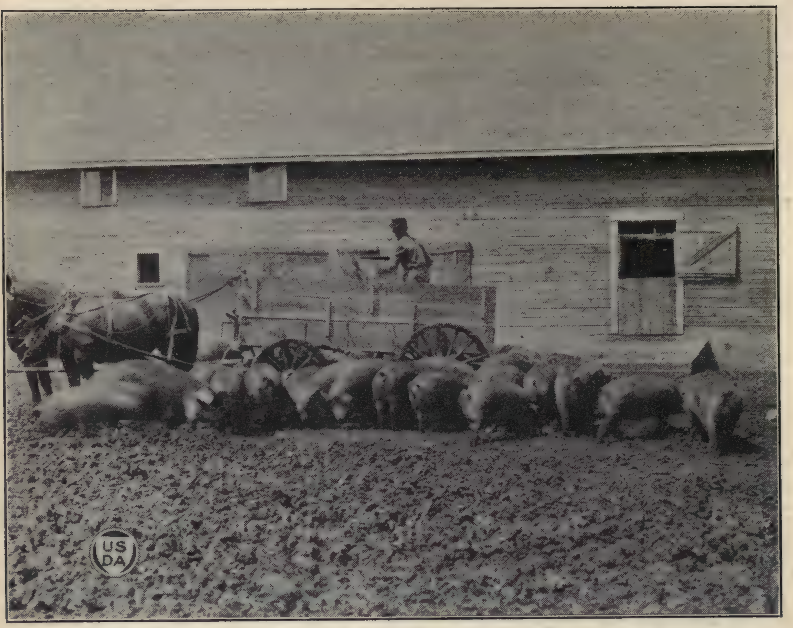

FIG. 4.—A good meal improperly served. This method of feeding shelled corn makes it a mixture of grain and filth.

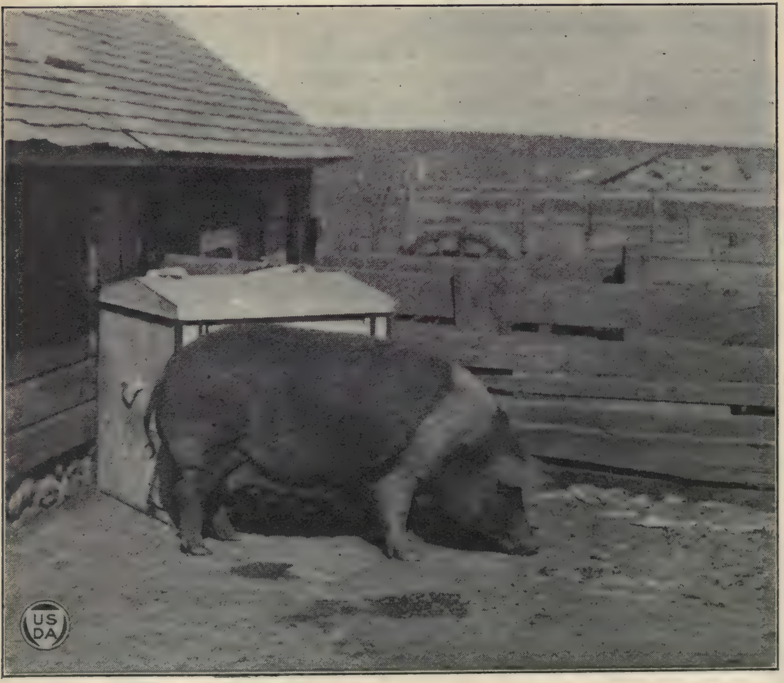

FIG. 5.— A good meal properly served. Corn fed on a clean concrete floor.

POISONING.

Poisoning in swine is quite a common occurrence. There are several forms in which the symptoms resemble those of hog cholera, but practically all cases of poisoning are devoid of fever, which eliminates the diagnosis of hog cholera.

Causes.—Hogs may be poisoned by feeding on spoiled feed, frosted alfalfa, an excessive diet of cottonseed meal, or by poisonous plants. Poisoning may also occur from feeding garbage containing such compounds as lye, other caustics, and irritating substances. Cocklebur poisoning is of more or less frequent occurrence. Sometimes hogs are poisoned by eating too much salt, and frequently through drinking meat brine, of which the animals are fond. In sections where the deadly nightshade grows there is more or less poisoning from that plant. Carelessness in the handling of disinfectants in the hog lots, such as carbolic acid, bichlorid of mercury, cresol compound, etc., may result in poisoning the hogs.

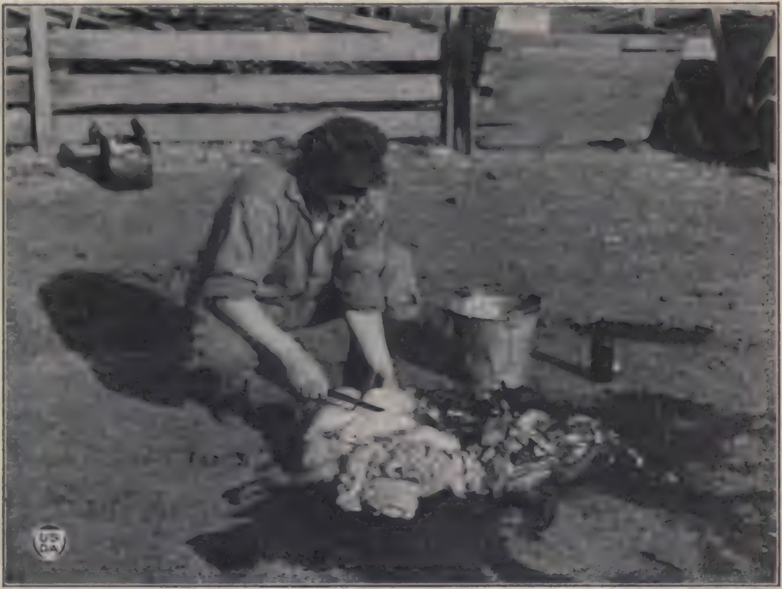

FIG. 6.—Examining a hog carcass for indications of poisoning and disease. After such examination, hands and instruments should be washed and disinfected and the carcass burned.

Symptoms.—The symptoms shown in these various forms of poisoning are more or less similar in character. Salt poisoning creates an intense thirst, restlessness, suppression of appetite, vomiting, colicky pains, diarrhea, frequent urination, muscular weakness, and sometimes paralysis. These symptoms, with the exception of frequent urination, apply fairly well in cases of lye, mercury, and cocklebur poisoning. Cottonseed-meal poisoning produces irregular or suppressed appetite, thumps, unthriftiness, weakness, unsteady gait, and, in severe cases, blindness. The deadly nightshade produces nausea, vomiting, increased respiration, excitement, and convulsions. Unless the source of the trouble is known, it is very difficult for the layman to distinguish between the various forms of poisoning.

Lesions.—The changes in the bodies of hogs dead of poison vary with the nature of the poisonous material taken. In cases of salt poisoning there will be found intense inflammation of the lining of the stomach and sometimes a quantity of blood free in the stomach and bowels. Caustics will also produce inflammation of the stomach and intestines, with erosions of the mucous membranes in various places. Cocklebur poisoning causes similar inflammation of the lining of the stomach and intestines, with sloughing patches of the membrane in the intestines. Not many changes are noticeable in cases of nightshade poisoning, except a distension of the bladder owing to the retention of urine, and the blood is usually darker than under normal conditions. Cottonseed-meal poisoning produces inflammation of the digestive organs and congestion of the lungs. Fluid is found in the thoracic and the abdominal cavities, and the fatty tissues have a yellow cast.

Treatment.—Medical treatment for any form of poisoning is of little value except when the cause is known and the condition is detected in the early stages. As soon as the cause of the trouble is determined it should be removed or the animals turned out to pasture land that is free of poisonous plants or forage, if such is available. Administration of emetics to those hogs that are not too sick is in order, followed by purgatives. The hogs should have access to a plentiful supply of clean drinking water, and should be kept off heavy feed for a number of days.

RACHITIS (Rickets).

Rickets is a disease or condition impairing or interfering with the development of the bony structures in young animals, the ailment being quite common in pigs.

Cause.—Rickets usually has its origin in a diet deficient in bone-forming salts or other elements. The ailment is likely to begin about weaning time, when the pigs are placed on solid feed that is not well balanced in nutritive elements.

Symptoms.—As a rule, the first symptoms noted are those of digestive disturbance, such as loss of appetite, bloating (pot-bellied), and weakness. On close observation deformity in the bones of the legs will be seen. Severe pains develop in the muscles, bones, and joints of locomotion, and the pigs walk with a " stilty ", lame gait. These symptoms are followed by enlargement of the bones of the legs, especially at the joints, and the long bones become quite bowed. Finally, there is a loss of weight and the pigs affected become runts of the worst type.

Treatment.—The development of rickets may be avoided by proper attention to the feeding of pigs after weaning time. Properly balanced rations, with salt and charcoal available, will insure the bone-building properties formerly provided in the milk of the mother. A good field of alfalfa is a good place for growing pigs. The alfalfa may be supplemented with a little bone meal. The pigs should have plenty of room for exercise, plenty of sunshine and pure drinking water, with clean, warm sleeping quarters. If necessary the bowels should be kept active with doses of Epsom salt. These precautions will effect a recovery in a large percentage of the pigs already affected if taken in the early stage. Deformed, runty pigs seldom make satisfactory gains.

RHEUMATISM.

Rheumatism in swine may be of two types, muscular and articular, though the muscular type is the more common.

Cause.—Although rheumatism may be caused by absorption of toxic material, the ailment is the result mostly of exposure to cold, wet weather. Among hogs that are shipped a long distance in winter many of the animals later become subject to rheumatism, although the condition may not be recognized as such, or may be entirely overlooked.

Symptoms.—In either type of rheumatism the first symptoms noted are those of difficult locomotion. The animals move in a slow, painful way. In the articular type the joints become swollen and sensitive to the touch. There is lameness and if more than one leg is affected the hogs are disinclined to walk. The appetite is impaired. Many cases of posterior paralysis are probably the result of muscular rheumatism.

Treatment.—Treatment for rheumatism is of little avail. The animals should be kept comfortably housed and away from cold drafts. They should be fed a laxative diet and made to exercise as much as possible under favorable weather conditions.

SKIN DISEASES.

Considering the filthy conditions of living to which hogs are commonly subjected, skin diseases are not so prevalent as might be expected. The chief disorders of the skin in swine are eczema, or "soot," of pigs, sometimes known as "pitch mange" or "pitch scabs"; erythema, which is a simple reddening of the skin without inflammation; swine erysipelas or urticaria, commonly called diamond skin disease; and mange (hog itch). Mange is fully discussed in Farmers' Bulletin 1085, Hog Lice and Hog Mange.

Cause.—The common factor responsible for practically all forms of skin diseases in swine is the filthy condition in which the hogs are raised and kept. While skin ailments may result from other causes, such as scalding, frostbites, strong dips, irritating liniments, or may appear as a symptom of an infectious disease, such as hog cholera, in the majority of cases the causes are found in the insanitary hog lot, the filthy wallow, and lousiness. Skin disorders sometimes result from improper feeding, which leads to constipation and the absorption of toxic material. Swine erysipelas results from the invasion of a specific organism and is regarded as infectious.

ECZEMA.

Eczema, while rare among mature hogs, is not uncommon in pigs. It is usually seen as a secondary ailment in pigs left unthrifty as the result of disease, such as chronic cholera, chronic indigestion, rheumatism, rickets, scours, and heavy infestation of lice.

Symptoms and lesions.—Eczema first appears in the form of red elevations of the skin in various parts of the body, accompanied by severe itching that causes the animals to rub at frequent intervals. On the reddened portions of the skin there appear small blisters filled with a sticky fluid which later turns into pus. When these blisters break a scab is formed. In prolonged or aggravated cases the skin becomes thickened and cracked.

ERYTHEMA.

Symptoms and lesions.—Erythema is characterized by diffused redness of the skin, readily seen in white hogs but often overlooked in red and black ones, in which types the lesions are hard to detect except on close inspection of the lighter parts of the body, such as the belly and the inner aspect of the hams. If pressure is applied to the red areas the color disappears only to return on removal of pressure. In this condition there is but little itching as a rule.

Treatment.—Sanitation in the hog lot is the keynote of treatment in swine diseases of the skin. Sanitation and proper attention to the feeding of the herd will generally remove the annoying causes. The cleaning and disinfecting of hog lots and shelters are important as well as the dipping of the animals to rid them of parasites. The hogs, pigs, and shotes should have access to rubbing posts well supplied with crude oil or other insecticide. If a concrete wallow is part of the equipment on the place, the oil may be poured on the water and the animals in wallowing will get the benefit. The same results may be had by providing a wallow of fine sand saturated with the oil. In those conditions of the skin where itching is a persistent factor, an oil or ointment, such as carbolated vaseline or olive oil, may be used to allay the irritation. A corrective diet, along with a purgative of Epsom salt or linseed oil, will be beneficial.

SWINE ERYSIPELAS.

Swine erysipelas exists to some extent in the United States and is recognized most frequently as the so-called "diamond skin disease."

Cause.—Recent investigations have demonstrated that the particular form of swine erysipelas known as diamond skin disease is caused by a specific germ infection. This germ, *Erysipelothrix porci*, is the same as that which causes acute swine erysipelas. Consequently, diamond skin disease is now considered as being a chronic form of swine erysipelas.

Lesions.—The skin lesions of swine erysipelas usually consist of well-defined, slightly elevated, diamond-shaped areas, of a dark-red color. In more extreme cases the reddened or inflammatory condition of the skin may extend over considerable portion of the body surface. In such cases there may also be more or less necrosis and sloughing of the skin.

Treatment.—Local treatment in this form of skin affection would prove of little value. It is quite probable that many animals so affected recover without treatment.

URTICARIA.

Urticaria, also known as "diamond skin disease," assumes a similar appearance to that of swine erysipelas. From a clinical observation it is not possible to differentiate one ailment from the other.

Cause.—Urticaria may result from various factors causing irritation and subsequent inflammation of the skin. Feeding on buckwheat ration has been known to produce the lesions, and other feeds of a similar nature may bring about the condition through digestive disturbance.

Lesions.—The lesions are practically the same as those of the chronic form of swine erysipelas. See page 20.

Treatment.—A corrective diet and removal of the irritating factors will usually overcome the ailment. A purgative of Epsom salt is in order.

SPASMS AND CONVULSIONS.

Cause.—Spasms and convulsions are usually the symptoms of diseases affecting the brain or nervous centers, although they may be induced occasionally from a disturbed digestion. Chief among such conditions may be mentioned vertigo, also known as blind staggers, and epilepsy (fits).

Symptoms.—Spasms are not so pronounced in blind staggers as in epilepsy. Vertigo, or blind staggers, comes in a sudden spell of dizziness; the animal appears blind, and moves about aimlessly. There is a staggering gait and finally the animal falls on its side. The symptoms may disappear entirely in the course of two or three hours.

Epilepsy is characterized by general restlessness, muscular tremblings, jerking of the head and legs, and prostration. Violent convulsions occur, during which there may be discharge from the natural openings of the body. These attacks may occur in rapid succession.

Treatment.—When either vertigo or epilepsy results from abnormalities or disturbed functions of the brain or nerve centers, there is not much hope of overcoming the conditions. However, since these symptoms may occur from the heavy feeding of material hard to digest, heavy infestation of worms, or acute inflammation of the stomach and bowels, it is well to pay some attention to these factors, and an attempt should be made to remove such causes if they exist. The bowels should be cleaned of irritating matter with a physic of Epsom salt. The animal should be fed a light diet of slops, bran mashes, and the like. If the condition persists, there may be some deep-seated cause which is impossible to remove.

SPASMS OF THE DIAPHRAGM (Thumps).

"Thumps" in swine or other animals is synonymous with hiccough in the human, and is due to an overstimulation of the pneumogastric nerve, which in turn causes a spasmodic jerking of the diaphragm (midriff).

Cause.—Thumps is usually brought about through a lack of exercise and also by improper feeding, particularly in young pigs, in which class of animals the ailment is most commonly seen. It may occur as a symptom of digestive diseases, such as gastritis (inflammation of the stomach), enteritis (inflammation of the intestines), or heavy infestation of worms. It is often associated with hog cholera, and with swine plague (hemorrhagic septicemia) it is almost always a constant symptom. Recent investigations have brought out the fact that worm embryos migrating through the lungs of young pigs also cause thumping.

Symptoms.—Thumps is easily recognized and the name implies practically all the symptoms. There is a continued series of spasmodic contractions of the diaphragm which cause the animals to jerk in a peculiar way, the flanks drawing in and the chest walls out at each jerk. At times the pigs are dull and listless, and if the ailment is due to indigestion there is the accompanying constipation and impaired appetite.

Treatment.—If the condition is of dietetic origin and is observed and treated in its early stage, it is not a serious ailment. Should the case be overlooked or neglected, however, it may run for a considerable period with a resulting loss of flesh and with stunting. As a rule, a physic of some kind, either linseed oil or Epsom salt, will correct the trouble. The pigs should be given wide range, light and airy quarters, plenty of sunshine, and for a few days fed a light diet.

STOMATITIS (Sore Mouth).

Stomatitis is an inflammation of the mucous membrane of the mouth and is quite common in swine, although little attention is given to the ailment.

Cause.—Stomatitis may occur from a number of causes, such as injury from rough or frozen forage, stubble, fermented silage, pieces of wood or sharp metal, nails, bones, or bearded grains. It sometimes results from "snubbing" large hogs for ringing, castrating, or immunizing. Irritating chemicals, hot feed, poisonous molds, or germs in filthy wallow holes may also cause the condition.

Symptoms.—As a rule, when stomatitis is noticed in swine it has reached the secondary stage, at which time there is profuse salivation and drooling. The mouth is held open, the membrane is hot to the touch, and the animal refuses hard feed. Thirst is a noticeable factor.

Treatment.—Stomatitis can easily be prevented by proper care in the feed lot. If garbage is fed, a close watch should be kept to see that no injurious ingredients are present in such feed. Feed on clean floors or platforms. Keep the animals away from filthy wallow holes. When hogs show signs of sore mouth they should be examined closely for possible foreign bodies lodged in the inside of the mouth. Give the animals access to clean cold water where they can cool the affected parts. Chlorate of potash added to the drinking water is of much benefit, using it in proportion of three teaspoonfuls to the pail of water. Feed bran, middlings, and milk until the condition has improved.

NECROTIC STOMATITIS (Infectious Sore Mouth).

Cause.—Necrotic stomatitis has been classed as a form of necrobacillosis. It is mostly confined to young pigs and is the result chiefly of keeping the animals in filthy hog lots and their having access to mudholes and accumulation of old manure. The organism of necrosis, *Actinomyces necrophorus*, gains entrance into the tissues of the mouth through abrasions or lacerations. The ailment has been known to spread rapidly in a litter through the suckling of sows with contaminated teats.

Symptoms.—Perhaps the first symptom noted is that the pigs refuse to suckle or eat, acting dull and listless. There may be a slight elevation of temperature. On examining the mouths of the animals there is found a number of inflamed areas or patches on the gums, lips, and hard palate, which later develop into necrotic ulcers. There is a sloughing of the tissues accompanied with a disagreeable odor. The centers of the sloughed patches are white or yellowish white in appearance. The pigs are unable to eat owing to the severe pain and in a short time become weak and emaciated.

Treatment.—Necrotic stomatitis can be easily avoided by following the common rules of sanitation in the hog lot. Pens and lots to which the pigs have access should be kept clean, free of old straw nests and manure piles. At least once or twice a month a coating of slaked lime should be applied to the floors of pens and shelters, as well as in the lot when such space is not too extensive. When the disease makes its appearance the pigs affected should be put by themselves away from the balance of the herd, along with the mother if they are still suckling. Washing of the mouth should be done immediately, using a solution of permanganate of potash in the proportion of 1 ounce of the permanganate to 1 gallon of water. If the sloughing is not too extensive and the value of the pigs justifies it, each ulcer may be rubbed with a stick of caustic potash or silver nitrate, repeating this treatment once a day for a week. When the lesions are extensive and the pigs stunted in growth it is a waste of time to attempt treatment and such animals should be destroyed.

Because of the resemblance of necrotic stomatitis to foot-and-mouth disease it is important to report all such cases to the proper authorities for prompt investigation.

WORMS.

Severe infestation with worms will cause symptoms in pigs somewhat similar to those of hog cholera. While hogs are seldom free from worms, the older hogs are not, as a rule, disturbed to any great extent by their presence.

Symptoms.—In pigs, worms cause a general digestive disorder resulting in unthriftiness, weakness, and emaciation. Worms that infest the lungs cause an irritation in those organs which commonly results in a bronchitis, characterized by a husky cough, and which may develop into pneumonia. Even if pneumonia does not result, the worms are more or less detrimental to the growth of the animals. When the worms infest the intestines there is an impairment of the general health. These parasites, which sometimes attain a length of 10 inches or more, cause an irritation of that part of the alimentary tract resulting in digestive disturbances which give rise to diarrhea or constipation. They interfere materially with the absorption of food and the pigs become pot-bellied, have rough coats, and show signs of general unthriftiness. The absence of fever and the fact that only the pigs in the herd are involved serve to distinguish the condition from cholera.

Treatment.—Sanitary hog lots, well drained, and treated with a coat of slaked lime at frequent intervals, will do much toward preventing worm infestation. It is especially important to protect young pigs from worms, and the system known as the McLean County system of swine sanitation has been found very effective in protecting pigs against worms, bullnose, cholera, and other diseases. It consists in putting clean sows in clean farrowing pens, moving the sow and pigs to clean pasture, and keeping them there until the pigs are four months old or more. There are various methods of treatment to rid swine of worms. Chenopodium (wormseed oil) may be given in doses of one drop of oil for each 2 pounds of live weight, mixed with about 2 ounces of castor oil for each animal. For example, a 30-pound pig should receive 15 drops of wormseed oil and 2 ounces of castor oil. Animals weighing over 100 pounds should be given 3 to 4 ounces of castor oil. Keep the pigs off feed overnight before treatment. Santonin is a reliable vermifuge if used in repeated doses, but is rather expensive. It is given in the following mixture and the amount indicated is for a 50-pound pig: Santonin 2½ grains, calomel ½ grain, freshly ground areca nut 1 dram, sodium bicarbonate ½ dram. This may be given in a light feed of slop, but the efficacy of the drug is impaired if mixed with feed. Since santonin is most effective when given in repeated doses, and since swine are difficult to handle and dose, the chenopodium treatment is more satisfactory, and experiments show that it is more effective.

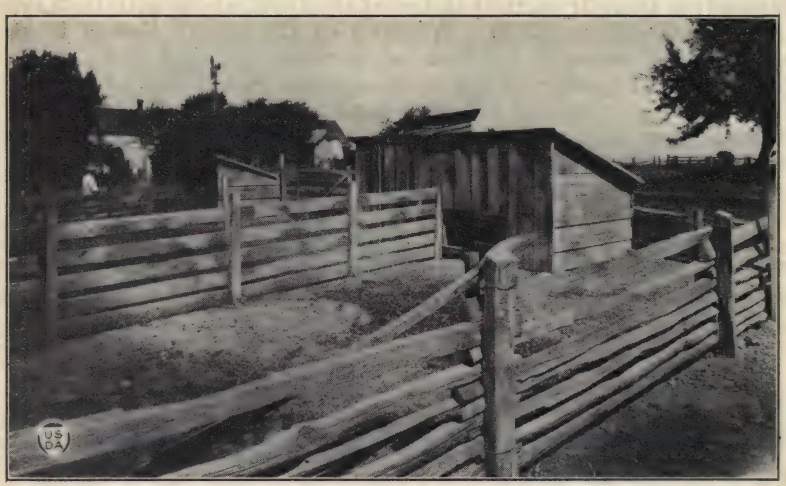
FIG. 7.—Properly cleaned and disinfected hogpens and shelter.

THE PREVENTION OF DISEASES.

In all diseases, ailments, and abnormal conditions of swine, the sane, simple, and effective method to adopt is one of prevention. While only a few individuals in a herd may be sick or unthrifty at one time, the fact should not be overlooked that under common conditions on the average farm the entire herd is exposed to parasites, inclement weather, and injury, as well as being subjected to improper methods of feeding.

Practically all the diseases and ailments discussed, particularly those of a noninfectious nature, can be prevented by proper care in feeding and housing. Most of the infectious diseases touched upon may be avoided through sanitation (Fig. 7), quarantine, and immunization. Pigs, shotes, and old hogs should not be allowed to feed from the ground. Suitable feeding floors or platforms, preferably of concrete, and troughs of some nonabsorbent material that can be cleaned, washed, and disinfected frequently, are recommended. Some sort of automatic drinking fountain which does not overflow should be provided (Fig. 8). If a wallow hole is deemed necessary, that also should be of concrete, so that it may be cleaned and disinfected from time to time.

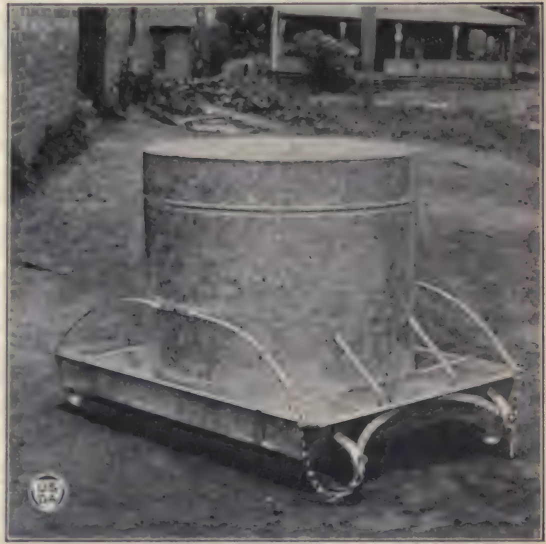

FIG. 8—Sanitary drinking fountain.

Frequent cleaning of pens, sheds, shelters, and hog lots, as well as troughs and feeding floors, is an important factor in disease prevention. Disinfection of premises should follow outbreaks of infectious diseases. In addition to thorough cleaning at stated intervals, a liberal amount of slaked lime should be applied in pens, houses, and adjoining lots. These precautions and the sanitary equipment suggested, while meaning a little added expense in the raising of hogs, will pay for themselves in a short time from the saving of feed and the protection of the animals' health. When disease appears in the herd no time should be lost in calling a veterinarian so that a correct diagnosis may be made and proper treatment administered.

LOSSES IN SHIPPING SWINE.

As a supplement to this discussion of swine diseases it seems advisable to touch upon the losses sustained each year by swine growers and farmers in the shipment of hogs to market. The number of dead and crippled animals found on arrival at stockyards is an item worthy of consideration as a factor bearing on the amount of marketable pork to say nothing of the consequent effect in decreasing the farmer's profit on the entire shipment.

During a period of six months in 1922 there was received at 9 of the principal stockyards of the country a total of 28,375 dead hogs and 38,708 in a more or less crippled condition, according to reports obtained through the Federal meat inspection service. These figures indicate clearly a waste that is largely unnecessary, most of which can be attributed to carelessness on the part of those handling the animals at points of origin of shipments.

Aside from wrecks, and extreme weather conditions, there seems to be no logical reason for so many hogs dying between points of origin and destination. Much fault in this respect is attributed to improper handling of swine just prior to shipment. Quite often hogs about to be shipped are rushed to some small inclosure, penned up in a crowded way, and fed a heavy ration preparatory to being hauled or driven to the stock car. In getting them to the loading point, frequently the animals are prodded, kicked, and hurried until worried into a highly nervous condition. Such hogs are often loaded in cars containing sharp pieces of broken timber, nails sticking out of boards, and in which the flooring is covered with mud and rubbish, no precaution being taken to remedy these dangerous conditions. Often no bedding of any kind is provided. Under such circumstances many of the animals reach the yards badly crippled, the injuries commonly involving the hind quarters, resulting in lowered quality of the most valuable cuts—the hams.

When ready for market, hogs should be assembled a sufficient length of time prior to the date of shipment to allow them to become rested. They should not be crowded into small pens or houses nor fed heavy rations. If they are driven to the loading point they should not be rushed on the way; if they are hauled, too many hogs should not be crowded into the truck or wagon. The loading chutes should not be too steep, should be made secure, and have the sides protected so that the animals will not fall off. Crowding too many hogs in a car, particularly in hot weather, is likely to result in a number of them dying in transit. Loading hogs after a heavy feed is injurious to them. A little hunger is far better for them on the journey than indigestion. There is nothing to be gained in added weight of the animals by forced feeding just before shipping. The aim should be to get as many of the hogs as possible to the stockyards in good condition.

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FARMERS' BULLETIN No. 1245

FARMERS TELEPHONE COMPANIES

Organization, Financing and Management

THE need for telephone service is as great in the country as in the city or village, perhaps even greater, because of the relative isolation of farm homes. Yet less than two-fifths of our country homes have telephones.

This bulletin aims to make available information that will assist in the extension of telephone service to rural districts now without it and in the improvement of existing rural service where improvement is needed. It deals with the general problems of organization, financing, and operation of rural telephone systems, touching only incidentally upon the technical and engineering problems of the subject.

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FARMERS' TELEPHONE COMPANIES: ORGANIZATION, FINANCING AND MANAGEMENT.

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There are 13,500,000 telephones in the United States, 2,500,000 of which are on farms. Figures of the 1920 Census of Agriculture show that 38.9 per cent of all farms, or approximately two farms out of five, have telephones. This ratio varies greatly according to locality. In Iowa, for instance, 5 farms in every 6 have telephones, while in South Carolina only 1 farm in 18 is so equipped. (Fig. 1.)

The problem of those who want telephone service will differ according to the relative development of the telephone business in their localities. Thus in the Corn Belt, as the accompanying map (fig. 1) shows, there is little need for the formation of new companies. In this section the country is already well covered. The farmers still without telephones will want to know how they may best connect with existing systems, and the chief concern of those who are managing established companies will be that of improvement rather than material extension. In the South Atlantic Division and in some of the Mountain States, on the other hand, very little has been done toward establishing rural service.

In the South, lack of telephone service is largely due to the nature of land tenure, a large proportion of the farms being operated by tenants on short-time contracts. Commercial companies hesitate to build lines with the prospect that after the construction is completed the subscribers may move and leave the lines idle. For the same reason, tenants do not often put in telephones, since they can not afford to build lines only to leave them. Few Southern landlords have felt enough need of telephone connection with their tenants to arouse any great interest on their part in the development of rural service.

The difficulties met with in the Western States are of a different nature. The rugged country and great distances are the chief causes for the lack of telephone service. In some localities farmers have overcome these handicaps by using barbed wire fences for lines. While such lines are not to be recommended, except in emergencies, they are better than nothing and may serve until they can be replaced by better construction.

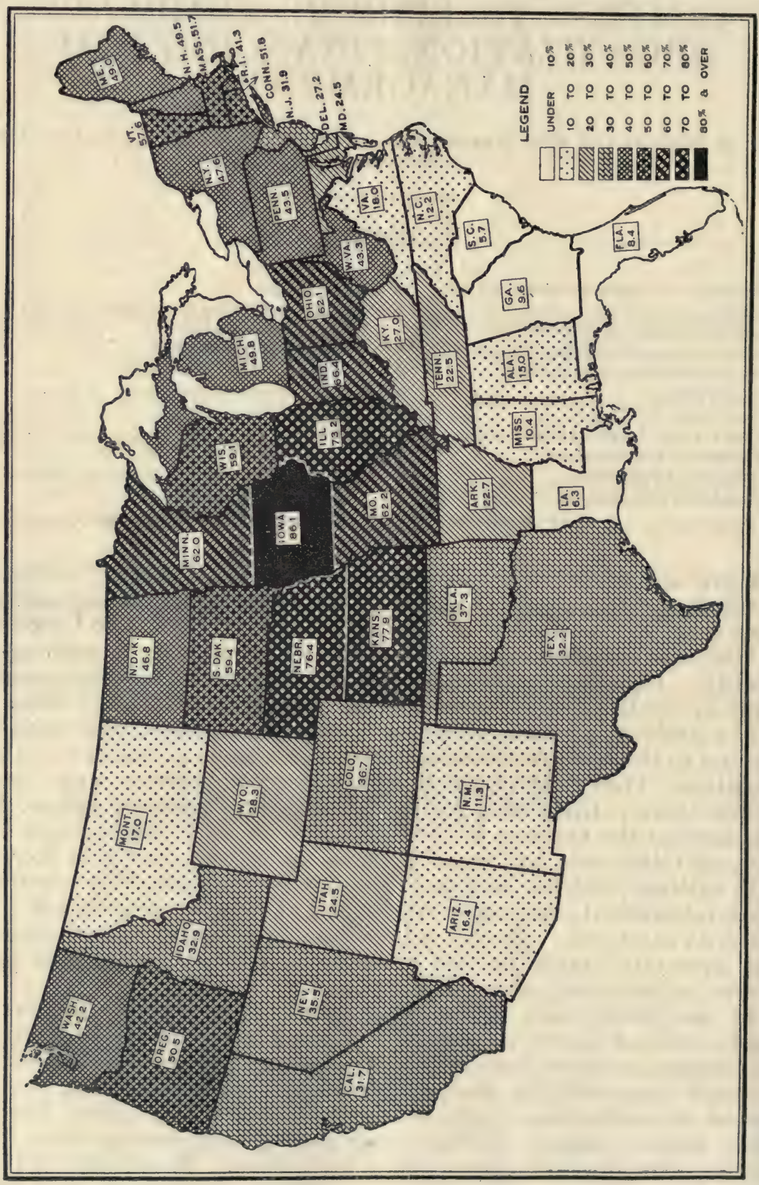

FIG. 1.—Percentage of farms having telephones.

DEVELOPMENT OF TELEPHONE SYSTEMS IN RURAL DISTRICTS.

Alexander Graham Bell entered his first patents on the telephone in 1875. Since then the development of the industry has been remarkable, in regard both to growth and improvement in service. At first telephone messages were considered as possible over short distances only, and the sending of a message from Boston to New York in 1884 was considered a great feat. Now people on the Atlantic coast may talk with friends on the Pacific coast, 3,000 miles away. By wireless telephone, Paris and New York have been brought within speaking distance.

From the late seventies, when the first commercial companies were organized, until the expiration of the first patents, the extension of telephone lines was confined chiefly to the larger cities. It was all the new industry could do to keep up with the ever-increasing demand in the business centers, and not until toward the end of the century was marked progress made in the establishment of small town and rural lines.

With the expiration of the second Bell patent, in 1894, a fever of competition arose among the independent promoters and the numerous manufacturing concerns that quickly came into existence. The fact that the larger cities had already been more or less thoroughly equipped made it necessary for the new companies to extend the telephone business into the unworked territory of the smaller towns and rural districts. Although the majority of the companies organized at this time were promoted honestly, there were some unscrupulous promoters who took advantage of public interest, and by poor equipment and dishonest methods, delayed rather than promoted the extension of rural telephone service in certain districts.

Stimulated by the competition from new companies which were everywhere springing up, the city companies also began to extend their lines into the country. In spite of these efforts there were still a great many sections which were not reached. The only way of getting service in such cases was the building of cooperative telephone systems which were locally owned and operated.

During the 10 years following 1896, great waste resulted from the building of two or more systems in territory that could support but one. Such duplication, often resulting from unfair charges on the part of the company first in the field, limited the number of telephone connections possible for any subscriber unless he had a telephone in each system. This unsatisfactory and often very annoying condition was one of the reasons that led to the supervision of telephone companies by State commissions and by the Interstate Commerce Commission.

By 1910, 18 States had placed telephone companies under the control of State commissions, and during that year the Interstate Commerce Commission was given control over telephone companies doing an interstate business. At the present time, telephone companies are subject to commission control with regard to rates, service, and other matters in all States, except Delaware, Iowa, and Texas. In

Iowa, however, the lines of telephone companies must cross railroads in a manner prescribed by the State railroad commission, and in Delaware and Texas there are specific sections of the law that regulate the building and operation of telephone lines. Among the benefits which have resulted from commission supervision or control of telephone companies are reasonable rates for service, and a tendency toward the elimination of unnecessary duplication.[1]

Statistics concerning telephone companies in the United States were collected in connection with the censuses of 1880 and 1890, and a special census of the telephone industry has been taken every fifth year since 1902. The United States totals for the more important items have been compiled from the census reports and are presented in Table 1. There were 148 telephone systems in 1880, which operated 437 public exchanges, averaging 124 telephones each. In 1890, there were 53 systems, which operated 1,241 public exchanges, averaging 188 telephones each. Although there were fewer systems in 1890 than in 1880 there were more and larger exchanges in operation.

TABLE 1.—*Number of telephone systems, public exchanges, telephones, and miles of wire for different classes of companies—United States totals (census figures).*

Year and class.	Systems.	Public exchanges.	Telephones.	Miles of wire.
Unclassified:				
1880, all companies	148	437	54,319	34,305
1890, all companies	53	1,241	233,678	240,412
Classification, by type of company:				
1902—				
All companies	9,136	....	2,371,044	4,900,451
Bell companies	44	3,753	1,317,178	3,387,924
Other commercial companies	3,113	5,666	908,803	1,391,647
Mutual companies	994	942	89,316	70,915
Farmer or rural companies [1]	4,985	....	55,747	49,965
1907—				
All companies	22,971	....	6,118,578	12,999,369
Bell companies	175	5,418	3,132,063	8,947,266
Other commercial companies	4,726	9,284	2,294,910	3,470,776
Mutual companies	368	825	125,956	95,033
Farmer or rural companies [1]	17,702	....	565,649	486,294
Classification, by income:				
1912—				
All companies	32,233	....	8,729,592	20,248,326
Bell companies	176	5,853	5,087,027	15,133,186
Other companies with $5,000 or more	1,740	5,662	2,239,721	3,886,205
Companies with less than $5,000	30,317	....	1,402,844	1,228,935
1917—				
All companies	53,234	21,175	11,716,520	28,827,188
Bell companies	145	6,288	7,326,858	23,133,718
Other companies with $5,000 or more	2,055	6,006	2,626,852	4,164,308
Companies with less than $5,000	51,034	8,881	1,762,810	1,529,162

[1] Smaller companies with no regular exchanges or centrals of their own.

In the censuses of 1902 and 1907 telephone companies were classified as "commercial," "mutual," and "independent farmer" or "rural" lines, but in the census of 1912 this classification was changed to one based on annual income. The companies having an annual income of less than $5,000 in 1912 and 1917 were, of course, not all farmer and rural lines, but by comparison with the figures for the two preceding periods it would seem that a large percentage of these smaller companies were of that class. In view of the fact that there are a considerable number of rural telephones on the lines of larger city companies, concerning which no definite information is available in the census, it is probable that telephones in rural districts numbered at least 2,000,000 in 1917.

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[1] For a list of these commissions see page 29.

Although the number of independent telephone companies, including both commercial and mutual lines, has more than doubled since 1907, the Bell system has grown even more rapidly. In 1907 the 22,796 companies outside the Bell system owned 48.8 per cent of the number of telephones in use, and the Bell companies 51.2 per cent. In 1912 the Bell system owned 58.3 per cent, and in 1917, 62.5 per cent of all the telephones in use in the United States. Moreover, an increasing percentage of independent companies are being connected with the Bell lines. These facts indicate a tendency toward cooperation, as well as consolidation among companies making possible telephone connection between almost all points in the United States.

METHODS OF OBTAINING TELEPHONE SERVICE.

The building of independent telephone systems is not desirable when there are already established companies in the locality unless such companies are unfair in their methods or unreasonable in their demands. A needless duplication of systems is always to be discouraged, and cooperation with existing companies for the extension of their lines and service is greatly to be desired. In most cases a local company will meet a group of prospective members or subscribers halfway on the question of the extension of service. The commercial companies usually have a definite program for the extension of their service to rural districts. Three principal methods of rendering service in rural areas are employed by such companies:

(1) An extension of the company's city line to a rural subscriber, furnishing him with complete city service. For this the subscriber pays regular city rates plus an additional charge based on the distance of his telephone from the city limits. To telephone men this charge is usually known as an "extra exchange line mileage charge."

(2) An extension of a line by the company beyond the city limits, in this case to connect a number of subscribers. Since all of these subscribers, generally 5 to 16 in number, must share the same line, the company offers a rate lower than that generally charged in the city proper, although it generally approximates the rate for four-party line service. Such rural subscribers are said to receive "rural-line service."

(3) The construction and maintenance of a company line to or near the city limits only. The telephone instruments and all further construction and maintenance are provided by individual farmers or by associations. This is known as "service-station service."

Agreements for service-station service generally require that the association or subscriber shall perform the following duties: Construct and maintain all pole lines and wires up to a predetermined point; provide and maintain the necessary telephone instruments and other equipment; pay, in accordance with the rules and regulations of the company, the regular rates as established for exchange and toll service; guarantee payment at the established rate for not less than a given average number of telephones for each line or for each mile of line; limit the number of telephones on any one line to a maximum number prescribed by the telephone company; pay its proportion of the taxes and assessments of every kind and assume liability for all damages which may result from its line or the use thereof.

The company, on the other hand, agrees to perform the following duties: Provide and maintain a line connecting the service-station line to its central office; furnish to service-station patrons the same service given other subscribers;[2] assist the service-station subscriber or association with reasonable engineering advice and supervision in the building and maintenance of its lines; where facilities exist, lease circuits and attachment space on its pole lines at regular rates; list service-station subscribers in its local directories and furnish such subscribers with copies of each issue of the directory.

As a rule, the telephone company will not connect with service-station lines which, in its opinion, are not capable of giving good service.

The charge for extra exchange line mileage averages about 25 cents per station per quarter mile per month in addition to the regular city rates. Rural line residence rates for a large class of commercial companies vary from $1 to $3 per month, the average being about $2. Service-station residence rates are much lower, inasmuch as the only expense assumed by the company is that of switching and of maintaining a relatively short line. With few exceptions, the rates under this plan vary from 25 to 75 cents per month per telephone, the average charge being about 50 cents per month.

It occasionally happens that a local independent company furnishes free switching service to a small organization that maintains no switchboard. The explanation of this seems to be that access to the telephones of the local company or association receiving the free service is considered of material value to the switching company and to its subscribers. The methods of mutual and independent companies as a rule, however, are similar to those of commercial companies. In most cases they make a fixed charge for each telephone receiving exchange service, and in some a flat yearly charge is made covering switching done for all the members of an association.

Contracts regarding exchange of service between two companies when each maintains its own switchboard are of a different nature. (See p. 23.)

ORGANIZATION OF A RURAL TELEPHONE COMPANY.

If no satisfactory rural line service is available in a given locality, the only means of securing telephone service for a group of individuals is through the organization of a local company. The United States Department of Agriculture recently made a study of more than 450 companies of this type, and the following suggestions as to organization and operation are based on the experience of these existing systems.

A company may be organized either as a local unit for obtaining service-station service from some larger local company or as an independent operating company which maintains its own switchboard. In the former case care must be taken to comply with the rules of the company from which it is proposed to secure switching service, while in the latter the organizers are freer to work out their own ideas.

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[2] When service-station telephones are connected with toll stations local service is usually restricted to communication with the toll station and to other service stations connected with the toll station, and toll rates to all other points are the same as those applying from the toll stations.

As the first step toward organizing a company it is necessary to get the cooperation of a number of leaders in the community. Before anything is done to arouse general interest in the undertaking this group should determine the kind of organization to be formed and the general type of system which is best suited to local conditions. They should also make at least a preliminary estimate of the cost and be ready to suggest plans for raising funds.

KINDS OF TELEPHONE ORGANIZATIONS.

There are two general types of business organization, the commercial or profit-seeking company and the mutual or cooperative association. Both types are found among rural telephone companies. The commercial company may be either a private enterprise or a stock company, while the mutual association may be either a pure mutual or stock mutual.

The privately owned rural telephone system frequently belongs to a single individual who owns a switchboard or central exchange and furnishes switching service to a number of local rural lines. In other cases, such systems may include the exchanges of several towns.

The commercial stock company may have few or many stockholders. Where the stockholders and subscribers are not the same individuals, the company is looked upon the same as any other public-service corporation by its subscribers and the public. On the other hand, if a majority of the subscribers are stockholders, it may closely resemble a stock mutual, even in regard to management and control.

The pure mutual organization is operated solely for the convenience of its members. All members share in the management, either directly or through their representatives, and each bears his prorata share of the expenses of the enterprise. As a rule, each member owns his telephone and equipment, no fixed charges for service are made, and the necessary assessments are reduced to a minimum through cooperation, each member keeping in repair his own instrument and a portion of the line.

The pure mutual type of company is well adpated to the operation of small country systems consisting of one, or at most of only a few lines, more especially when no switchboard is maintained. If such a company consists of more than a single line, switching service is usually obtained from a neighboring company.

The stock mutual differs from the pure mutual type in several respects. Instead of prorating the costs among its members, the stock mutual, as its name implies, issues shares of stock, which are sold to those desiring telephone service. Ordinarily, only one share of stock is sold to a member, but this practice is by no means universal. Sometimes the voting privilege of members is determined by the number of shares of stock held, each share carrying one vote, but more commonly each member is allowed only one vote, regardless of stock held. The stock mutuals often have subscribers who are not members, and in most cases a regular yearly charge is made for service to all subscribers, the charge to nonmembers being somewhat higher, as a rule, than that to members. Dividends are seldom paid on the stock of such companies, the shares being in most cases little more than certificates of membership. The shares may not be transferred without the approval of the company, and must usually be surrendered at par upon the withdrawal of a member or the discontinuance of the service. In other respects, the stock mutual is not unlike the pure mutual, having the cooperative plan of organization and management.

The private concern and stock company for rural service are usually centered in a town of small or medium size, with lines branching out into the surrounding country, and the pure mutual is often found on short lines in more or less isolated districts. The stock mutual seems to be the most common. Out of a group of 252 rural telephone companies studied, 3 per cent are private concerns, 15 per cent stock companies, 27 per cent pure mutuals, and 55 per cent stock mutuals.

INCORPORATION.

There are many points in favor of incorporation, particularly for larger mutuals. Although such action may seem to involve more formality than necessary for the simple organization of a local association, an incorporated company is governed by specific laws which are a direct benefit to the company. The incorporated company enjoys certain rights which can not be exercised by the unincorporated company. In some States incorporation gives the company the privilege of taking necessary land for right of way and other purposes at an appraised value, by what is known as the right of eminent domain, while in other States this right may be obtained upon petition to the State commission having supervision over such companies.

Moreover, the members of an incorporated company are protected by having a limited liability, while the liability of the members of an unincorporated company is unlimited. Of 33 companies in a certain locality from which reports on this point were received, 20 were incorporated. All but one of the incorporated and five of the unincorporated companies recommended incorporation.

Advantages of incorporation are well illustrated by the following examples. In the case of one company, a pole fell and killed a horse. The company was incorporated and its members were liable only to the extent of the par value of their stock, the loss being distributed in proportion to the shares held by each member. In another case, fallen wires across a road wrecked an automobile and injured the occupants. A damage suit was brought. This company was not incorporated and a few telephone owners on the line were held for all damages.

On the other hand, incorporation places the company under the supervision or control of some State commission or board, and makes necessary more careful bookkeeping and the submission of certain reports to State officials.

In the case of a small local company it might not seem advisable to incorporate, more especially if the company is not to be operated for profit.

If it is decided to incorporate, the State law should be consulted, as the form for the articles of incorporation is usually prescribed by law. Unless the State commission can be relied upon for legal assistance, it is well to secure the advice of a competent lawyer with regard to the requirements. Thus delay and possible financial loss may be avoided.

CONSTITUTION AND BY-LAWS.

Although mutual organizations which are not conducted for profit are seldom required to have a legal charter or to incorporate it is wise for all concerned to have a written agreement in the form of a constitution and by-laws. Suggested forms for such agreement will be found on page 25. Alternate sections, applicable to the pure mutual or to the stock mutual type of organization, are given. In using this form for a pure mutual company, all sections which are inclosed in parentheses should be omitted. Thus, Article I, section 1, of the by-laws would read: "Each member shall pay into the treasury of the company a membership fee of $3 for each telephone," etc. For the use of a stock mutual organization, all sections printed in italics should be omitted and sections in parentheses included. In this case the section quoted would read: "Each member shall buy one share of stock in the company, for each telephone," etc. If these by-laws seem too elaborate, or if certain sections are not required for the purpose of the company, only the sections which are applicable need be used. If the members of a short line are organized very informally, it is possible that the only rules they will require are contained in the article on "Rules for service and the use of lines," while a somewhat larger organization in which the members construct and maintain their own lines might omit the parts relating to the board of directors and change the other articles to fit their needs.

TYPES OF RURAL TELEPHONE CONSTRUCTION.

There are two general types of telephone construction which may be used in rural districts, the grounded or one-wire system and the metallic or two-wire system.

For short lines the grounded system may be used to advantage. This type of system is cheaper to build than the metallic, since only one wire is needed, the ground being used to complete the circuit. Of the grounded systems for which reports are available, 44 per cent state that the grounded lines are satisfactory. There are many conditions, however, which tend to interfere with good service on grounded lines. These lines are frequently subject to buzzing noises which can not be eliminated. In very dry weather when there is little moisture in the ground, the ringing will be weak and the talking faint over a grounded line. In very cold weather, also, when the earth is frozen, the grounded telephone line will not give good service unless the ground connection is well below the frost. Where electric light circuits or trolley lines are too near the telephone line, it is almost impossible to use a grounded system.

The metallic system, in which two wires are used to make the complete circuit, is free from these particular defects, although when near electrical circuits and power lines such systems must also be protected from interference by a special arrangement of the two wires. A somewhat stronger pole line and twice the length of wire are required, but in other respects the equipment is practically the same as for the grounded system.

In a grounded system the magneto, or local battery type of telephone, is the only one that can be used. But in a metallic system there is a choice between the magneto and the central battery type. A variation of the central battery type is found in the automatic system, which is discussed on a later page. The magneto type of telephone is usually found on rural lines, while the central battery system is better for city service where a permanently located exchange is maintained.

PRELIMINARY ESTIMATE OF COST.

Chief among the causes which have encouraged the organization of local rural telephone companies has been the desire to obtain service at low cost. While the matter of low cost is highly important if telephone service is to be placed within the reach of all, the question of efficiency in service must not be overlooked. Poor service is unsatisfactory at any price, for telephone service to be of real value must be available when it is needed. Moreover, actual financial loss may result from the purchase of instruments and the building of lines which are either defective in themselves or unsuitable for the uses to which they are to be put. On the other hand, it is poor economy to provide an expensive and complicated system if a simpler one which costs less will answer the purpose fully as well. In the long run, the most economical system is the one that gives satisfactory service with the least demand for repairs and replacement, rather than the one that has the lowest original cost.

A study of the original costs of 252 companies, which averaged 73 members each, shows that the average cost for all these companies was $2,110. In other words, the original cost per member was about $29. Almost 50 per cent of the companies reporting had an original cost per member of $25 or less. In only 12 per cent of the companies was the cost $50 or more, while in 2 per cent the cost was more than $100 per member. These figures apply to systems constructed before war-time prices went into effect, and the average cost is doubtless lower than companies can hope for at present in spite of the recent decline in prices of materials and equipment.

The material needed for each mile of line, aside from poles, is given below, together with the approximate cost for each type of construction based on price lists issued by a number of manufacturers early in 1922.

Grounded line, bracket construction:
30 12-inch oak brackets.
30 pony glass insulators.
30 40-penny wire nails.
30 60-penny wire nails.
165 pounds No. 12 BB galvanized-iron telephone wire.
Approximate cost, $16.50.

Metallic line, bracket construction:
60 12-inch oak brackets.
60 pony glass insulators.
60 40-penny wire nails.
60 60-penny wire nails.
330 pounds No. 12 BB galvanized iron telephone wire.
Approximate cost, $33.

Grounded line, six-pin cross-arm construction:

30 6-pin cross arms.
180 1½-inch locust pins.
30 pony glass insulators.
60 cross-arm braces.
165 pounds No. 12 BB galvanized-iron telephone wire.
30 machine bolts.
60 carriage bolts.
30 lag screws.
30 square washers.
30 round washers.

Approximate cost, $53.

Metallic line, six-pin cross-arm construction:

30 6-pin cross arms.
180 1½-inch locust pins.
60 pony glass insulators.
60 cross-arm braces.
330 pounds No. 12 BB galvanized-iron telephone wire.
30 machine bolts.
60 carriage bolts.
30 lag screws.
30 square washers.
30 round washers.

Approximate cost, $68.

If there are four subscribers for each mile of line, each member will of course have to bear one-fourth of the above-mentioned cost per mile.

The material needed for installing each telephone and the approximate cost is as follows:

2 batteries.
1 lightning arrester.
15 feet single wire.
20 feet paired wire.
6 2-inch screws.
1 bridging wall telephone, 5-bar, 1,600-ohm.
4 porcelain knobs.
4 3-inch iron screws.
2 8-inch porcelain tubes.
12 ¾-inch insulated staples.
1 6-foot iron ground rod.

Approximate cost, $19.

These figures indicate that the cost per member, exclusive of the cost of poles and switchboard, where bracket construction is used, will be about $23 on a grounded line and $27 on a metallic line. In case of cross-arm construction it will be about $32 for members on grounded lines and $36 for those using metallic circuits.

Those rural companies which plan to operate switchboards will find the approximate cost of boards of various sizes in the following list:

5-line ringer board, about	$55
10 to 15 drop wall board, about	100
30 drop wall board, about	250
40 drop wall board, about	350
50 drop cabinet board, about	400
75 drop cabinet board, about	500
100 drop cabinet board, about	600
150 drop cabinet board, about	800
200 drop cabinet board, about	1,100

To the above costs per member comprising one-fourth of the cost of a mile of line plus the cost of installing a local telephone plus the cost of a part of the switchboard, if there be one, must be added the cost of the poles, unless these can be furnished by members without cash outlay. For a well-constructed line 30 substantial poles per mile are needed. A grounded line with a single wire may, however, be constructed with fewer poles if it is certain that additional wires will not be needed. While smaller poles are often used by farmers' mutual companies, experts recommend a pole 6 inches in diameter at the top and about 25 feet in length. Where such poles have to be bought from a distant market the cost per member is likely to equal or exceed the cost per member for all the other material.

In selecting poles even greater care should be used than in selecting timber for high-grade fence posts. Short lived or weak poles represent false economy, because the cost of replacing them almost invariably more than offsets the original saving in cost. In addition to this, there is the danger of damage to property or persons.

The above estimates are based on the assumption that there will be only one circuit on the poles. When the same pole line is to carry more than one circuit the cost of the additional equipment must be added. Moreover, no allowance has been made for the cost of labor, on the assumption that in the majority of cases the members themselves construct the line.

Mutual companies sometimes require each member to build a certain portion of the line and to buy and connect his telephone. This method is not a real financial saving, as is that of furnishing poles and labor, for each individual is obliged to pay out a certain amount of cash to fulfill his obligation to the company. It will be found more economical to have all matters pertaining to the purchase of equipment handled by one individual or by a purchasing committee. Through the purchase of larger quantities a better price may be obtained from the manufacturer. Furthermore, the advantage of securing equipment of uniform quality is of considerable importance, since it is generally admitted that a system gives better service if all the instruments are of the same kind. Of the mutual lines of which the Department of Agriculture has record only 10 per cent had a portion of the lines constructed by each member, while 90 per cent collected the cost of the equipment in cash and built the line as a company enterprise.

Before attempting to make an exact estimate of the cost of a proposed telephone system it would be advisable to get the catalogues of a number of manufacturers of telephone equipment and supplies, a list of whom may be secured by writing to the Department of Agriculture at Washington, D. C. After a careful comparison of equipment of the type decided upon, offered by the several companies, a letter setting forth the details of the proposed system should be addressed to the company selected. Care should be taken to present all points which would in any way affect the system, such as the general lay of the land, nature of the soil, distances to be covered, presence of electrical circuits, probable number of subscribers, and the greatest extension of the system that may be hoped for in the future. If suitable poles can be obtained locally this should also be mentioned. Manufacturers are glad to give prospective customers the benefit of advice from their expert engineers in making estimates of requirements and cost.

METHODS OF RAISING FUNDS.

There are four general methods of raising funds for the construction of a telephone system, namely, by sale of stock, by voluntary subscription, by fixed or pro rata assessment, or by borrowing. In companies where the ownership of stock is made the basis of membership, the price of shares is usually fixed at an amount which is expected to insure sufficient funds. In case, however, that not enough shares are sold, or the price has been made too low, an additional assessment is usually made against the stock. In some stock mutuals members are originally assessed pro rata and the amount so assessed is taken as the value of one share of stock. In pure mutual companies funds may be raised by voluntary subscription or the members may be assessed pro rata for their proportion of the cost.

Borrowing may be resorted to in the case of any company that finds funds available. Sometimes a leading business man or the local bank will advance funds for the construction of a telephone system which is almost certain to work for the general benefit of business more than for that of any one individual. Only about 1 per cent of the companies reporting, however, resorted to borrowing as a means of raising funds for construction.

Among the stock mutual companies reporting, 81 per cent raised funds entirely through the sale of stock, 4 per cent by sale of stock and assessment, and 15 per cent by assessment. Among the pure mutual companies, 69 per cent raised funds by fixed assessments and 31 per cent by voluntary subscriptions. The companies that reported borrowing money for construction were either private concerns or stock companies, and only 6 per cent of the latter used this method, the remainder raising funds by the sale of stock.

As a rule it will be found better to raise the funds among the members. The particular method of deciding each member's share is not of very great importance. The main thing is to raise enough funds in a single subscription to insure success for the undertaking. It is undoubtedly easier to secure a slightly larger payment in the first place than it is to collect additional funds from members who thought that they were paying all that would be required in the beginning.

COMPLETION OF THE ORGANIZATION.

When all important matters relating to the proposed organization have been agreed upon by the leaders in the enterprise, and it is desired to interest the whole community, a public meeting should be called. At this meeting the best speaker available should present the subject. He should have clearly in mind the advantages which such a system would bring to the business and social life of the community. He should also have approximate figures of the cost of the system, and an outline of the form of organization.

At the close of this meeting a temporary organization should be effected by the election of temporary officers and the appointment of a membership committee and a committee on constitution and by-laws. If the proposition seems to have met with general approval, it may be proper to take subscriptions for membership or stock before adjournment. Much travel and canvassing can, of course, be saved if subscriptions can be secured at this meeting. If, however, little interest has been shown, it would probably prove unwise to push matters too fast. Many an organization is spoiled by a failure to use reasonable tact.

Assuming that enough subscriptions have not yet been secured, it should be the duty of the membership committee to see that the territory is thoroughly canvassed. They may divide the territory among themselves and cover it individually, or, if the farms are too widely scattered, they may secure the coöperation of those already pledged and have them take up the matter with their friends and neighbors. All possible publicity should be given the matter, and the period of solicitation under no circumstances should be long enough to allow the original interest to die out in the meantime. The campaign for members should be as short and as lively as possible.

When enough members have been secured to make the undertaking a financial success, the first regular meeting of the company should be called by the temporary chairman. At this meeting the formal organization should be completed through the adoption of a constitution and by-laws and the election of directors, after which the next step is to proceed with the construction and operation of the system.

COST OF SERVICE.

The important factors which have been found to affect the cost of service on lines for which information is available are the size of the system, the extent of its territory, the type of construction, the quality of service demanded, and the efficiency of management.

In the telephone industry, the cost per subscriber increases as the number of subscribers in a system increases. As the system becomes larger, more complex equipment is needed, increasing the company's investment per subscriber. Furthermore, with an increased number of connections more calls per telephone tend to be made. Thus the cost of unlimited service in the larger cities becomes almost prohibitive. In such places the general practice is to allow each subscriber a certain number of calls each month with an extra charge for each call in excess of that number.

The average annual service charges of 250 rural companies, as presented in Table 2, clearly illustrate the tendency for costs to increase with the size of the company.

TABLE 2.—*Average annual charges for service per telephone for different types of companies, by size groups.*

Size groups.	All types of companies.[1]	Joint-stock companies.	Stock mutual companies.	Pure mutual companies.
Not operating switchboard	$11.57	$18.34	$10.10	$9.38
Operating switchboard:				
Systems of 1 to 50 lines	10.17	13.71	10.42	7.48
Systems of 51 to 100 lines	11.26	14.18	11.17	7.09
Systems of 101 to 200 lines	12.34	15.87	13.33	4.72
Systems of more than 200 lines	16.22	16.53	15.40	....
All systems	12.64	16.00	11.70	7.26

[1] There were not enough figures for privately owned companies to warrant the making of averages for this class.

Nearly all companies without switchboards have fewer than 50 lines. A comparison of their cost with the cost of companies of the same size operating switchboards appears to indicate that it is cheaper for a small company to operate its own switchboard than it is to obtain switching service from another company. It is probable, however, that these averages, particularly in the case of pure mutuals, represent current cost of operation only, and do not make due allowance for the expense of installing a switchboard of the required capacity. Therefore, although the reported cost of operation for companies which maintain their own switchboards is lower, it might still prove more costly for some companies to do their own switching when all the expenses involved are taken into account.

For pure mutuals, the annual service charge for telephones is relatively low, and unlike that for other companies decreases as the size of the company increases. This is due chiefly to the fact that in such companies members usually repair the lines and give other services to the company without charge. The only items of cost considered are those where cash is spent, and usually include merely the wages paid the operator and once in a great while the purchase of new equipment. Since the one operator required for 50 subscribers will usually handle up to 200 with little extra pay, the expense for each subscriber is naturally less when the number sharing the expense is larger.

The fact that the hire of the operator is the chief expense for mutual companies is clearly shown in Table 3, three-fifths to three-fourths of all money collected being spent for this purpose, while in the case of other companies less than two-fifths is so used. It may also be noted that the proportion of the total service income of pure mutuals spent for switching charge increases with the size of the company.

TABLE 3.—*Percentage of annual charges for service used to pay the cost of switching service for different types of companies, by size groups.*

Size groups.	All types of companies.	Joint stock companies.	Stock mutual companies.	Pure mutual companies.
Not operating switchboard	58.2	64.2	54.0	60.0
Operating switchboard:				
Systems of 1 to 50 lines	48.9	43.8	45.8	65.5
Systems of 51 to 100 lines	44.9	38.4	44.6	70.6
Systems of 101 to 200 lines	30.5	23.0	29.2	75.5
Systems more than 200 lines	29.1	28.8	30.0	....
All systems	38.8	32.2	40.7	66.1

With other than pure mutual companies, on the other hand, a smaller and smaller percentage of the income from service is used to pay switching charges until companies of more than 200 subscribers are reached. This means that a larger and larger part of the income is spent on the upkeep or improvement of the system, or a greater amount is paid out in salaries or dividends. The increase in the percentage of income used for operating expenses in companies of over 200 lines occurs because a single operator can not conveniently handle the calls on a switchboard of greater than 200-drop capacity, and the employment of additional operators becomes necessary.

Another factor which may require the spending of a larger percentage of income for repairs as companies increase in size, is that the larger companies are usually the older ones, and on account of their age are more in need of repairs and replacement than the companies recently organized.

As would be expected, systems operating over a large territory have higher costs of operation and maintenance than systems in which all subscribers live within a smaller area. The best measure of the area covered by a given system is the number of miles of pole line in use (Table 4).

TABLE 4.—*Annual cost of service per telephone as affected by number of miles of pole line in system.*

(Average for 197 existing companies.)

Miles of pole line.	Average annual cost.	Miles of pole line.	Average annual cost.
20 miles or less	$9.45	61 to 80 miles	$11.31
21 to 40 miles	10.87	81 to 100 miles	12.59
41 to 60 miles	10.36	More than 100 miles	12.84

The two types of telephone construction have already been discussed, namely, the metallic, in which the entire circuit is carried by wires, and the grounded, in which the return is through the ground. Metallic systems, by their very nature, are the more expensive to maintain. An average for 200 companies showed a yearly cost of $12.27 per telephone for metallic and $11.06 per telephone for grounded systems. But with their increased cost, metallic lines usually give proportionally better service. One important point should be kept in mind in this connection. When kept in repair metallic systems are the best, but they must be kept in repair. A poor metallic line is worse than a poor grounded line, as the ground will give better contact than a poorly-spliced rusty wire.

Quality of service is difficult to measure. The cost of service for existing mutual companies reporting their lines in good condition was found to be $11.36 per telephone per year as against $10.46 for those reporting lines in poor condition. This plainly shows that members of mutual lines must expect to pay a somewhat higher rate if they wish to keep their service up to the desired standard.

PROBLEMS OF OPERATION AND UPKEEP.

The general operation of a telephone company may be roughly divided into three parts: (1) The maintenance of the lines, (2) the switching and information service, and (3) the business administration, including bookkeeping and collections.

MAINTENANCE OF LINES.

Line maintenance may be handled in one or two ways (or variations or combinations of these ways), namely, by the employment of a regular lineman or by having repairs made by the subscriber. A majority of mutual companies use the subscriber plan, although many of them do not find this method satisfactory. The choice of method should depend upon local conditions.

Expert repairing undoubtedly keeps a telephone system in better condition, not only because work is done more thoroughly, but also because a regular lineman can do a great deal in the way of trouble prevention. On the other hand, it costs more to employ a regular lineman. Companies operating in sparsely settled regions find the cost of getting a repair man to the scene of trouble three or four times the actual cost of the repair work. Again, in very small companies, the share of expense falling on each member makes the cost of hiring an expert prohibitive.

Certain companies avoid some of the difficulties of nonexpert repairing by having one subscriber responsible for each line in the system. The subscriber who handles the work is usually given a reduction in his telephone rent or the free use of his telephone as compensation. This plan does effect a saving and at the same time centralizes responsibility, although it does not necessarily assure expert repairs. In other cases, a member of a mutual company who has had telephone-repair experience agrees to report for duty on any line when needed, receiving pay by the hour for actual time spent. This plan has usually proved satisfactory, although subscribers may find themselves without service for a few days if their line happens to be out of order while the repair man is doing rush work, such as harvesting.

Those mutuals which connect with larger commercial companies are often able to get help from the commercial concern when they need it, usually being charged the actual cost of the operation plus a small percentage for supervision. Minor repairs are then made by the subscribers.

In general, expert work has been found preferable where its cost has not been too great.

LOCATION OF SWITCHBOARD.

Rural line switchboards may be found in private homes, stores, rented offices, or in separate buildings owned or rented by the companies.

Private home installation is confined almost exclusively to the smaller companies which can not afford to rent or build separate offices. The owner of the house is paid a small rent and some member of his family is usually made operator, and paid for this service. The advantages of such a system are evident. The rent for switchboard space is usually small, in many cases amounting only to a rebate of telephone rent to the house owner. Operator hire is also low, since the women of the house can do their regular housework and at the same time make the switching connections. Moreover, in case of emergency a night call will always receive attention.

Occasionally the switchboard is placed in a member's store instead of a private home. Some one must be on duty all day in a store and the switchboard can be looked after without requiring a special operator. Night calls, on the other hand, can not receive attention if the switchboard is in a store, unless special arrangement is made.

Either of the above plans is more suitable to a small system than to one so large that calls are so numerous as to require the hiring of a regular operator. When an operator is required on full time most companies will do well to rent a separate room or building. Many good reasons for this have been reported. Where the board is kept in the operator's home, a change of operators makes it necessary to move the board with all of its connections. The directors are also better able to control and regulate the operation of the switchboard in the company's own offices than they are when it is in the home of the operator. In a separate office the matter of night calls is not so easily handled. Either subscribers must be without service at night or someone must be assigned to regular night duty in the exchange.

A number of mutuals have solved these problems by building their central exchange buildings and making them large enough to include living quarters for the operators. Thus instead of moving the board to the home of the operator they move the operator to the board. An added advantage of this plan lies in the fact that the rent of living quarters is considered part of the operator's pay and thus, since the cost to the company is little more than it would be if only an office were rented, the cash outlay is somewhat lessened. All companies reporting this plan have found it satisfactory.

Some companies do business without owning switchboards. They either operate isolated lines or obtain their switching service from other sources. The single isolated line, where there are not too many members, needs no switchboard, since all telephones are on the same line and calls are made merely by the use of different rings. But this, of course, will not take care of long-distance calls.

Other cases are found in which large companies furnish switching service to independent lines on the service station plan, already mentioned, or in which merchants in small towns operate switchboards for the use of their patrons on country lines. Sometimes a family will operate a board for several independent lines and receive either a fixed monthly compensation or a small fee for each connection made between companies. In such cases members call others on their own line without the help of the board operator.

THE AUTOMATIC SWITCHBOARD.

Automatic service, or mechanical switching as it is often called, has recently been receiving considerable attention. Some advocate its use for small rural exchanges. A few such exchanges are now in operation and are apparently giving entire satisfaction, but the plan must be considered as still in its experimental stage.

The operation of the automatic telephone may be easily understood from an examination of the accompanying illustrations (Figs. 2 and 3.)

The dials which may be noted on the stand of the desk telephone and just under the transmitter of the wall telephone are used to call whatever number may be desired. For example, a person wishing to call No. 36 first takes down the receiver, then inserts his finger in the opening over number 3 and pulls the dial in a clockwise direction until his finger reaches the stop near the base of the dial. He then releases the dial which returns to its normal position by means of a spring. Next he "dials" No. 6 in the same way. He then pushes the button at the center of the wall box or on the front of the desk telephone base, as the case may be. This rings the bell at station 36 without the intervention of an operator. In case no one answers, the person ringing may again push the button. On some automatics a mechanical arrangement takes care of this feature, continuing to ring at regular intervals until an answer is received or until the person making the call hangs up his receiver, which clears the line in all cases.

The plan of calling different subscribers by a series of long and short rings is known as code ringing. There are two methods of code ringing. In one, the person calling pushes the button the desired number of times; in the other the ringing is automatic, the code being "dialed" in the same manner as explained above for "dialing" the number. For example, a person wishing to call No. 36, two rings, would "dial" 3–6–2. The ringers for all telephones on line 36 would automatically ring twice.

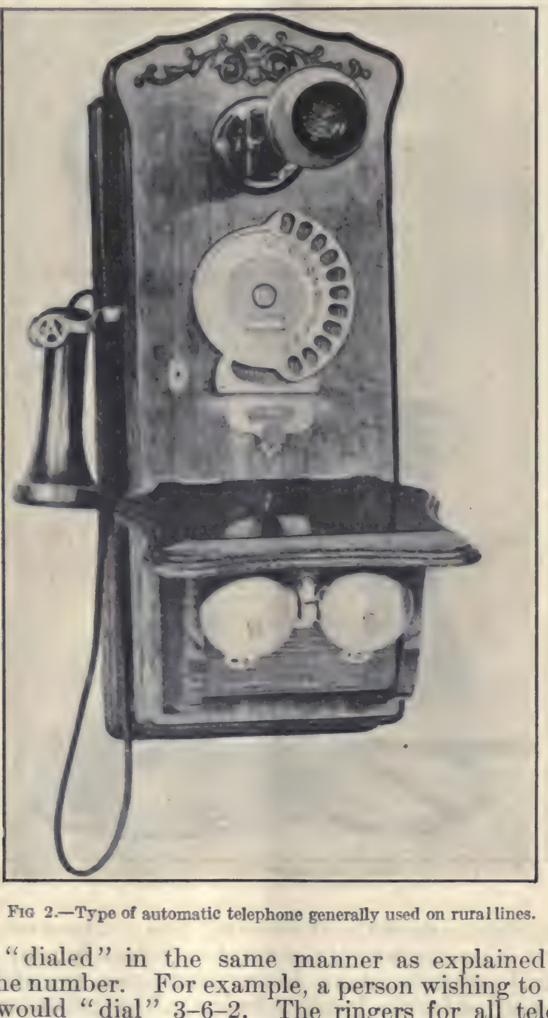

FIG 2.—Type of automatic telephone generally used on rural lines.

Such systems are not suitable for all conditions. In an isolated community, where connection with a hand-operated switchboard is not possible, 300 subscribers is usually the smallest number for which automatic service can be wisely considered. In such cases, an operator will be required for long-distance calls and therefore the automatic would not effect a saving, but would cost much more than a simple, hand-operated system. The equipment is more expensive and complicated than that needed for the regular magneto system, and requires expert attention, and the lines must be completely metallic and kept in perfect condition.

If the business of the line is such that two or more operators would be required for a hand-operated exchange, the automatic exchange makes it possible to do without some of them. The most satisfactory arrangement is one in which the local exchange is near enough to a larger central office to make direct connection possible. Here no operator is needed for the local exchange, all long-distance calls being handled at the larger central office, which is reached by ringing a special number. By such a plan, 24-hour service is possible without the necessity of hiring a special night operator, and at the same time the service is generally improved. On the whole, however, the automatic equipment is so complicated that it is usually better adapted

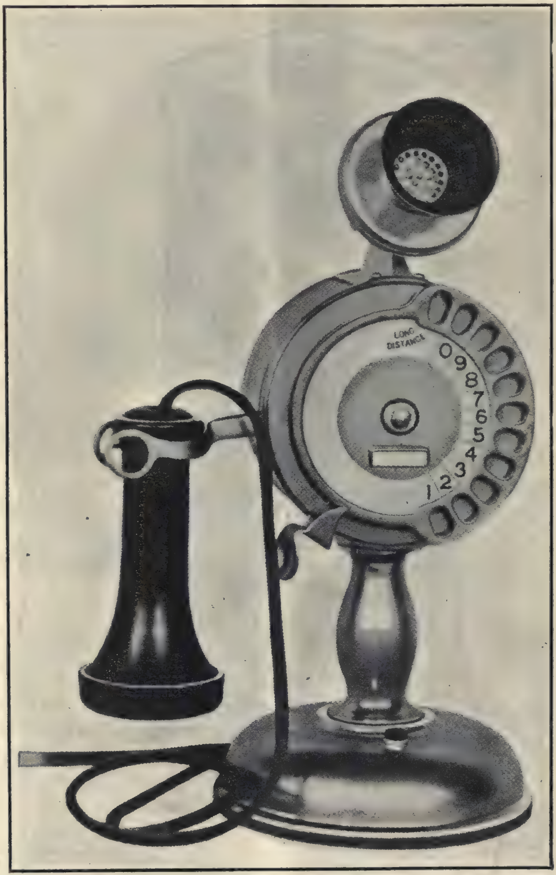

FIG. 3.—Detail of automatic telephones.

to the use of commercial concerns than to installation and operation by farmers' mutuals.

LONG DISTANCE CONNECTION.

Having established its central office, a mutual company will next be interested in getting long-distance service for its members. Interchange between farmers' companies within short distances is often on a mutual free basis, members of each company being glad of the opportunity for connection with members of the other. If the farmers' company is close to a town where a commercial concern operates, the town company often gives the farmers connections with its subscribers on what is called a switching fee basis. The farmers' line pays either a certain amount for each subscriber or a yearly lump sum for the entire membership in return for the privileges of such connections. This plan is much like "service-station service" already discussed.

For long-distance toll calls, connection with the large independent companies or the Bell system is required, either directly or through the switchboard of another small company. Generally when the toll fee is paid, a certain percentage, depending upon the amount of the fee, goes to the company on whose lines the call originates. The remainder is generally prorated on the basis of the mileage involved. Thus a company owning half of the wire over which a toll message is carried is allowed half of the toll fee, after the originating charge is deducted. A company owning all the wire would get the entire fee, with the exception of the originating charge.

Lines having long-distance connections require more care than those used only for local calls. Many commercial companies refuse to connect with grounded lines, but the usual requirement is that the line must be in such condition as to carry messages clearly.

BUSINESS ADMINISTRATION.

The management of a small mutual telephone company is a comparatively simple matter. Frequently, the levying of rates and the making of assessments is left to the decision of the members at their regular meetings, the chief duty of the management in this connection being the keeping of accounts and making collections. If interstate business is handled and the annual revenue is more than $5,000, the system of accounts prescribed by the Interstate Commerce Commission must be used. As has already been pointed out, further supervision of telephone lines is exercised in most States by State commissions, which, in many instances, prescribe accounting forms.

Collections are sometimes troublesome. Members may neglect their bills unless some inducement for prompt payment is offered. A small discount for payment in advance will encourage promptness. Most companies provide that subscribers more than 30 days in arrears shall have service discontinued. Assessments should not be too frequent. Mutuals will usually find payment in advance, once, or at most four times, each year, most satisfactory. The practice of sending monthly bills for small amounts not only annoys the subscriber but involves needless labor and expense.

Under most conditions, the publication of a telephone directory will be advantageous. Often advertising companies print directories without charge, getting their money by the sale of advertising space in the book. In addition to the directory proper, the book may contain the by-laws of the company, a set of rules for the use of the telephone, or instructions for making simple repairs in case of local trouble. These repair hints often help subscribers to make timely repairs without undue tinkering. Thus they may save trips for the trouble man and at the same time, by telling subscribers what not to try, may prevent their getting things into still worse shape.

Requests for information and advice in regard to special problems confronting those who wish to make use of the suggestions contained in this bulletin, will be given careful attention by the United States Department of Agriculture. The department is anxious to encourage and assist in the extension of suitable telephone service to all farmers. The rural telephone has fully proved its value both for social and business purposes, and there is no sound reason why this convenience should longer be denied to more than half of those living in country homes.

APPENDIX.

CONSTITUTION AND BY-LAWS.

The following constitution and by-laws were prepared after a study of the methods and practices of a large number of successful mutual telephone companies throughout the country. In using these forms it must be remembered that it is impossible to suggest a set of rules which meet all requirements in all States, and that changes may be found necessary in order to comply with State laws or local conditions. Even where such is the case, these rules or forms should be found helpful.

Where incorporation is decided upon the State law must, of course, be carefully consulted and all requirements met. The form here given under the title of "Constitution" may in such case be used as the basis for "Articles of Incorporation."

In adapting the following constitution and by-laws to the use of pure mutual companies, all words or sections in parenthesis should be omitted, while for the use of stock mutuals, sections or words printed in italics should be omitted and those in parenthesis included. Sections which are inapplicable to the form of organization desired may, of course, be omitted at the discretion of the organizers. For a more complete discussion of organization agreements see page 9 of this bulletin.

CONSTITUTION OF THE —— TELEPHONE CO.[1]

We, the undersigned citizens of the United States and of the State of ——, hereby associate ourselves as members of a mutual telephone company, and for this purpose adopt the following constitution:

ARTICLE I. This company shall be known as the —— Telephone Co.

ART. II. The principal office of this company shall be located in ——.

ART. III. The capital stock of this company shall consist of —— shares at $—— per share, and shall be increased only with the approval of two-thirds of the members at an annual or special meeting.

ART. IV. The business of this company shall be to provide telephone service for its members, by constructing, maintaining, and operating a suitable telephone system and to make connection with other companies for long-distance service for the convenience of its members, distributing among said members, equitably, as shall be provided in the by-laws, such costs and expenses as may be properly incurred.

ART. V. The territory of this company shall include ——.

ART. VI. Membership in this company shall be limited to persons who (buy stock therein, and) receive telephone service therefrom, as shall be provided in the by-laws.

ART. VII. The management of this company shall be vested in a board of nine directors, who shall be elected for such term and in such manner as the by-laws shall provide.

ART. VIII. Until the first annual meeting of the members, the following persons shall act as a board of directors:

Name.	*Address.*
....	....
....	....
....	....
....	....
....	....
....	....
....	....
....	....
....	....

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[1] Or "Articles of Incorporation."

Art. IX. The duration of this company shall be ——— years.

Art. X. This constitution may be amended by a two-thirds vote of the members present at any annual meeting, or any regularly called special meeting, a quorum being present, at least 30 days' notice of such proposed amendment having been given each member, in writing.

Signature of original members:

....

....

....

....

BY-LAWS

OF THE ——— TELEPHONE CO.

ARTICLE I.—MEMBERSHIP AND MEETINGS.

Section 1. Membership—Each member shall *pay into the treasury of the company a membership fee of* $——— (buy one share of the stock in the company), for each telephone which he has or intends to have connected with its lines or exchanges, or shall furnish the equivalent of that amount in poles, wire, apparatus, or labor, said equivalent to be determined by the board of directors, and shall be required to sign the by-laws of the company.

Sec. 2. Number of Telephones.—A member shall be entitled to have under the provisions of the preceding section one telephone in each house, store, office, or other building owned, leased or occupied by him or by the members of his immediate family.

Sec. 3. Annual Meeting.—The annual meetings of the members of the ——— Telephone Co. shall be held in ———, on the first Monday after the first Tuesday of each January at —— o'clock p. m., and the first regular annual meeting shall be held at that place on the —— day of ———, at —— o'clock p. m.

Sec. 4. Special Meetings.—Special meetings of the members may be called by the president whenever he or the board of directors shall deem such action necessary; and such meetings must be called by him for any special purpose upon petition of one-fourth the number of members.

Sec. 5. Notice.—At least five days' notice, in writing, shall be given each member of the time and place of each annual meeting, and of the time, place and purpose for which the meeting is called in the case of special meetings.

Sec. 6. Order of Business.—The order of business at any regular meeting shall be as follows:

1. Roll call.
2. Reading and adoption of the minutes of the last meeting.
3. Reports of officers.
4. Reports of committees.
5. Election of directors.
6. Miscellaneous business.

Sec. 7. Business of Special Meetings.—No business shall be transacted at a special meeting except that for which the meeting was called.

Sec. 8. Quorum.—At any annual or special meeting 12 members shall constitute a quorum.

Sec. 9. Vote.—At any annual or special meeting each member shall have one vote on all questions. In case of a tie the president shall cast the deciding vote. A majority vote of the members present shall be necessary to carry any question.

Sec. 10. Proxy.—No member shall be allowed to vote by proxy.

ARTICLE II.—DIRECTORS.

Section 1.—Number, Election, and Term.—Nine directors shall be elected by ballot at the first annual meeting of the members, to succeed the temporary board. Three directors shall be elected for three years, three for two years, and three for one year. At each annual meeting thereafter three directors shall be elected to serve for three years, or until their successors are elected.

SEC. 2. VACANCIES.—Vacancies on the board of directors may be filled by the remaining directors until the next annual meeting of the members, when a director shall be elected to serve for the unexpired term.

SEC. 3. EXECUTIVE COMMITTEE.—The executive committee of the board of directors shall be composed of the president, secretary-treasurer, and one other director designated by the board.

SEC. 4. MEETINGS.—The executive committee shall meet at least once a month, and oftener if necessary, and meetings of the entire board shall be held at the call of the president.

SEC. 5. QUORUM.—Five directors shall constitute a quorum at any meeting of the board.

SEC. 6. COMPENSATION.—The directors shall receive compensation at the rate of $—— for each day of eight hours actively employed in the interests of the company,

SEC. 7. ELECTION OF OFFICERS.—Immediately after the annual meeting of the members, the board of directors shall elect a president and a vice-president from their own number, and a secretary-treasurer who may or may not be a member of the board.

SEC. 8. APPOINTMENT OF MANAGER AND COMMITTEES.—The board of directors shall appoint, and may dismiss for cause, a manager who may or may not be a member of the company, or at their discretion the secretary-treasurer may also be the manager. They may appoint committees on financing, construction, etc., and it shall be their duty once a year, at least 30 days before the annual meeting of the members, to appoint an auditing committee to consist of three members of the company who are not officers.

SEC. 9. BOND.—The board of directors shall require the secretary-treasurer and may require other officers and employees charged by the company with responsibility for the custody of its funds or property, to give bond with sufficient surety for the faithful performance of such duties.

SEC. 10. SALARIES OF OFFICERS AND EMPLOYEES.—The board shall fix the salary of officers and the wages of all other employees of the company. No officer shall receive the per diem allowed the directors in addition to his salary.

SEC. 11. SEAL.—The board may devise and adopt an appropriate seal, and cause the same to be affixed to all documents whereto the company is a party.

SEC. 12. RECALL.—Any director, for just cause set forth at any annual meeting or special meeting called for that purpose, may be removed from office by a two-thirds vote. Such director shall be informed in writing of the charges made against him, at least 10 days before the date of such meetings, and shall have an opportunity to be heard in person, by counsel, and by witness in regard thereto.

ARTICLE III.—OFFICERS.

SECTION 1. TERM.—Each officer, unless removed by a two-thirds vote of the board, shall hold office for one year or until his successor has been elected.

SEC. 2. DUTIES OF THE PRESIDENT.—The president shall preside at all the meetings of the members and of the board; shall sign, execute, and deliver all legal papers pertaining to the business or property of the company; shall sign all notes, checks (certificates of stock), etc.; and shall perform such other and further duties as the board may direct.

SEC. 3. DUTIES OF THE VICE PRESIDENT.—In the absence or disability of the president, the vice president shall act.

SEC. 4. DUTIES OF THE SECRETARY-TREASURER.—The secretary-treasurer shall attend all the meetings of the members and of the directors, and shall keep, in books provided for that purpose, a correct record of the proceedings of each meeting.

(He shall keep the books of the blank certificates of stock; fill out and countersign all certificates issued, and make the corresponding entries on the stub of each certificate. He shall keep a proper transfer book, and a stock ledger showing the number of such shares issued to and transferred by the members.)

He shall receive all moneys paid to the company and give his receipt therefor, and shall pay out the same under the direction of the board; shall keep in a suitable book an accurate account thereof, and make a detailed report in writing at the annual meeting of the members, and at such other times as the board may designate. He shall make all reports and serve all notices required by the directors or by law or by these by-laws.

He shall be custodian of all the records and papers of the company; shall have charge of and affix the company's seal to all such documents as require attestation; and shall countersign all notes, checks, and other papers.

At the expiration of his term of office he shall turn over to his successor all the property of the company in his hands and take his receipt therefor.

SEC. 5. DUTIES OF THE MANAGER.—The manager shall have charge of the operation, inspection, and maintenance of the lines and equipment of the company, under the general direction of the board.

He shall appoint and may discharge all operators and other employees necessary for the proper conduct of the company's business, and such operators and employees may or may not be members of the company.

ARTICLE IV.—COMMITTEES.

SECTION 1. DUTIES OF AUDITING COMMITTEE.—It shall be the duty of the auditing committee to meet at least two weeks before the annual meeting of the members. They shall make a thorough examination of all the records and accounts of the officers for the preceding year and shall make a report thereon at the annual meeting.

SEC. 2. DUTIES OF OTHER COMMITTEES.—It shall be the duty of any other committee appointed to perform such work as may be assigned to it by the board, and to make a report thereof at the annual meeting next following.

(ARTICLE V.—ISSUANCE AND TRANSFER OF STOCK.)

(SECTION 1. ISSUANCE.—All applications for stock shall be submitted, with the recommendations of the secretary-treasurer and manager, to the executive committee for its approval, before any stock shall be issued to the applicant.)

(SEC. 2. CERTIFICATES.—The certificates of stock of this company shall be issued in such form as the board of directors may designate. Such certificates shall be signed by the president and countersigned by the secretary-treasurer, and shall bear the seal of the company. They shall exhibit the holder's name, the date of issuance, and the value of the share.)

(SEC. 3. TRANSFER.—Stock of the company may be transferred with the approval of the board of directors when removal or discontinuance of service makes such transfer desirable. The surrendered certificate shall be canceled before a new certificate shall be issued in lieu thereof. The receiver of the new certificate shall not already own stock in the company, except as hereinbefore provided, and shall be required to sign the by-laws.)

ARTICLE (VI) *V.*—FINANCES.

SECTION 1. FISCAL YEAR.—The fiscal year of this company shall commence on ——— and end on ———.

SEC. 2. ASSESSMENTS.—*Every three months, in ———, ———, ———, and ———, the board of directors shall estimate the financial requirements of the company, and shall levy an assessment upon the members in proportion to the number of telephones charged to each.*

(SEC. 2. RENTAL CHARGES.—Each member shall pay into the treasury, for each and every telephone accredited to him, the sum of $——— quarterly in advance. A discount of ——— per cent shall be allowed for payment of rental charges within 10 days after same become due. If such rental is not paid within 30 days after it becomes due, service shall be discontinued until payment is made.)

SEC. 3. SYSTEM OF ACCOUNTING.—The accounts of this company shall be kept in accordance with the rules laid down by the Interstate Commerce Commission, and of the State commission [2] having jurisdiction over the business of telephone companies.

(SEC. 4. USE OF CAPITAL FUNDS.—The funds collected from the sale of stock of this company shall be used only for the building and extension of the company's lines and for the installation of the stations of new members or subscribers).

(SEC. 5. USE OF INCOME.—The income received from rental charges, tolls, etc., shall be used in defraying the expenses of operation and the regular repair and upkeep of the lines.)

(SEC. 6. DEPRECIATION RESERVE.—Out of the annual income of the company, exclusive of capital funds, ——— per cent shall be set aside as a depreciation reserve, to be used for replacing the system as it wears out.)

SEC. 4. POWER TO BORROW MONEY.—*The board of directors shall have power to borrow money at its discretion not exceeding the total sum of $———. Loans in excess of that amount must have the consent of two-thirds of the members at any annual or special meeting.*

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[1] See list on p. 29.

Article (VII) *VI.*— Rules for Service and the Use of Lines.

Section 1. Hours of Service.—The operator of the switchboard shall be on duty from —— o'clock a. m. to —— o'clock p. m., on week days, and from —— to —— o'clock a. m. and —— to —— o'clock p. m., on Sundays and holidays.

Sec. 2. Emergency Calls.—Emergency calls made out of regular hours will be charged for at the rate of 25 cents per call. The operator shall receive four-fifths of the amount collected for such calls, in addition to any other salary or wages.

Sec. 3. General Calls.—A general call for all members, —— rings, may be made at any time by any member having information of particular value to all. This privilege, however, must be used sparingly.

Sec. 4. Use of Lines by Outsiders.—No member shall allow his telephone to be used by an outsider, other than the members of his immediate family, his employees, or guests of his household, without collecting a charge of not less than 10 cents for each such call. All such calls shall be charged against the member whose telephone is used and shall be paid for by him at the quarterly payment date.

Sec. 5. Time Allotment.—No person shall be allowed the use of the line for more than five minutes if another party is waiting to use it.

Sec. 6. Precedence of Calls.—Ordinary conversation may be interrupted when the use of the line is required for the transmission of business or professional messages. In such cases the use of the line should be courteously requested.

Sec. 7. Improper Language.—No abusive, profane, or obscene language shall be used over the lines of this company.

Sec. 8. Listening in.—No person shall take down the receiver for the purpose of listening to a conversation which is not intended for him. If the receiver is taken down and the line is found to be busy, it should be immediately replaced, except in the case of an urgent business or professional call.

Sec. 9. Enforcement.—It shall be the duty of each member to see that the provisions of this article are rigidly enforced, and to report any and all violations thereof to the manager.

Article (VIII) *VII.*—Penalties.

Any member who fails to observe the rules and regulations of this company, as set forth in these by-laws, or who fails to pay any charges made against him in accordance herewith for 30 days after having received notice that such are due, shall have his service discontinued until he shall have assured the board of directors in writing of his intention to observe such rules in the future or until he shall have met his obligations to the company.

Article (IX) *VIII.*—Amendment.

These by-laws may be amended by a two-thirds vote of all the members present at any regular annual meeting, or at any special meeting called for that purpose, a quorum being present, 10 days' notice of such proposed amendment having been given each member in writing.

LIST OF COMMISSIONS HAVING JURISDICTION OVER TELEPHONE COMPANIES.

State.	Name of commission.	Location.
Alabama	Public service commission	Montgomery.
Arizona	Corporation commission	Phoenix.
Arkansas	do	Little Rock.
California	Railroad commission	San Francisco.
Colorado	Public utilities commission	Denver.
Connecticut	do	Hartford.
Florida	Railroad commission of the State	Tallahassee.
Georgia	Railroad commission	Atlanta.
Idaho	Public utilities commission	Boise.
Illinois	State public utilities commission	Springfield.
Indiana	Public service commission	Indianapolis.
Iowa	Railroad commission	Des Moines.
Kansas	Public utilities commission	Topeka.
Kentucky	Railroad commission	Frankfort.
Louisiana	do	Baton Rouge.
Maine	Public utilities commission	Augusta.
Maryland	Public service commission	Baltimore.
Massachusetts	Department of public utilities	Boston.
Michigan	Public utilities commission	Lansing.
Minnesota	Railroad and warehouse commission	St Paul.
Mississippi	Railroad commission	Jackson.

LIST OF COMMISSIONS HAVING JURISDICTION OVER TELEPHONE COMPANIES—Contd.

State.	Name of commission.	Location.
Missouri	Public service commission	Jefferson City.
Montana	do	Helena.
Nebraska	State railway commission	Lincoln.
Nevada	Public service commission	Carson City.
New Hampshire	do	Concord.
New Jersey	Public utilities commission	Trenton.
New Mexico	State corporation commission	Santa Fe.
New York	Public service commission	Albany.
North Carolina	Corporation commission	Raleigh.
North Dakota	Board of railway commissioners	Bismarck.
Ohio	Public utilities commission	Columbus.
Oklahoma	Corporation commission	Oklahoma City.
Oregon	Public service commission	Salem.
Pennsylvania	do	Harrisburg.
Rhode Island	Public utilities commission	Providence.
South Carolina	Railroad commission	Columbia.
South Dakota	do	Pierre.
Tennessee	do	Nashville.
Utah	Public utilities commission	Salt Lake City.
Vermont	Public service commission	Battleboro.
Virginia	State corporation commission	Richmond.
Washington	Department of public works	Olympia.
West Virginia	Public service commission	Charlestown.
Wisconsin	Railroad commission	Madison.
Wyoming	Public service commission	Cheyenne.
United States	Interstate Commerce Commission	Washington, D. C.

O

THE PEACH BORER

HOW TO PREVENT OR LESSEN ITS RAVAGES

The Para-dichlorobenzene Treatment

A. L. QUAINTANCE
Entomologist in Charge, Fruit Insect Investigations

FARMERS' BULLETIN 1246
UNITED STATES DEPARTMENT OF AGRICULTURE

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1921

THE so-called peach borer, the larva of a beautiful clear-winged moth, has been for upward of 150 years one of the principal drawbacks to the successful cultivation of the peach. It feeds on the soft inner bark at the base of the tree, or on the adjacent roots, seriously injuring and frequently killing the trees attacked.

Few American insects have been more experimented with by entomologists and others than the peach borer, but until recently no very effective or practical method of control had been discovered. As a result of experiments begun by the Bureau of Entomology in 1915, it was found that this pest could be largely destroyed by the application around the base of infested trees of a volatile poison known as para-dichlorobenzene. This bulletin treats briefly of the life and habits of the insect; of the "worming" method of destroying the borers, suitable where only a few trees are to be treated; and of the para-dichlorobenzene method for use on trees 6 years of age and older. The chemical has already come into large commercial use with excellent results when applied according to directions.

Orchardists proposing to use para-dichlorobenzene for the peach borer are urged to employ only the pure chemical, which should be obtained of a fineness of granulated sugar or coarse salt.

Contribution from the Bureau of Entomology
L. O. HOWARD, Chief.

Washington, D. C. **October, 1921**

THE PEACH BORER:[1] HOW TO PREVENT OR LESSEN ITS RAVAGES; THE PARA-DICHLOROBENZENE TREATMENT.

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A VERITABLE SCOURGE.

Among insect pests attacking the peach few, if any, are more important or more serious than the peach borer. Its injuries each year, including the cost of control measures, amount probably to not less than $6,000,000. Throughout much of its range of distribution east of the Rocky Mountains, from Canada south to Florida, it is a veritable scourge and must be combated relentlessly if the peach is to be grown. Trees of all ages, from those in the nursery to the oldest relic, are subject to attack. In many parts of the country the insect is so abundant that most trees in orchards become infested within a year or so after planting.

The peach borer is a native insect and has been complained of in horticultural and other literature almost from the time of the introduction of the peach in this country by the early settlers. Its original food plants were doubtless the wild cherry and wild plum, and on these it can still be found. It attacks also other stone fruits, such as nectarine, apricot, prune, almond, plum, and a few other plants. It is, however, preeminently injurious to the peach.

CHARACTER OF INJURY.

Injury is done by the larva, or borer, in the course of its feeding. Trees are injured principally at or somewhat below the ground level, and galleries or burrows are eaten in the soft bark or cambium at the crown of the trees or along the larger roots (fig. 1). Young trees may soon be more or less girdled (fig. 2) and older trees so injured that their vitality and crop-bearing capacity are greatly reduced.

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[1] *Aegeria exitiosa* Say; order Lepidoptera, family Sesiidae.

Injured trees are, perhaps, more subject to infestation by certain diseases, such as root-rot, crown gall, and peach yellows, and are certainly less able to withstand periods of drought.

Infestation of trees by the borer is usually shown by an exudation, around the crown, of jellylike gum, more or less mixed with dirt and small brown pellets—the excrement, or frass, voided by the borers in the course of their growth (fig. 3). This exudation of gum is especially evident during moist or rainy weather.

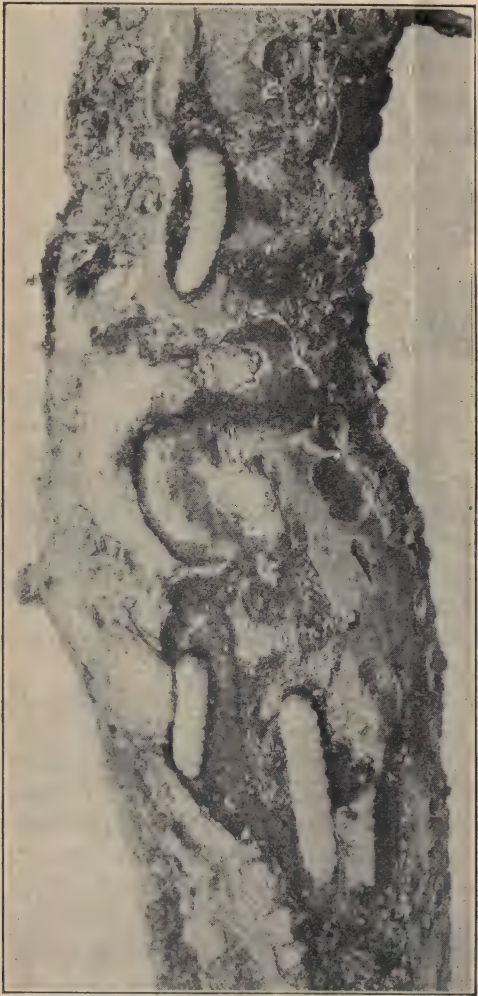

FIG 1.—The peach borer in its galleries at the crown of the peach tree.

HOW THE INSECT DEVELOPS AND LIVES.

The peach borer, in the course of its life, goes through four distinct stages—the egg; the larva, or borer; the pupa; and the adult, or parent moth.

THE EGG.

The eggs of the peach borer are small and inconspicuous, reddish brown in color, oblong in shape, and measure about $\frac{1}{50}$ inch in length (fig. 4). They are deposited rather promiscuously over the trunk, limbs, and foliage of the peach tree, and many eggs are laid on weeds and trash or on the ground at or near the base of the trees. The eggs hatch in about 10 days, though this period may vary somewhat. The abundance and destructiveness of the peach borer is due, in considerable part, to the fact that the moths are very prolific. Observations on the number of eggs deposited by a given female show that she may lay as many as 829 eggs, with an average of about 400.

THE LARVA OR BORER.

When the egg has hatched, the little larva coming out of it makes its way as rapidly as possible to the collar of the tree, if not already at or near its base, and at once begins burrowing into the bark, entering often through a crack or wound. Some of the larvæ enter on the trunk, or even on the limbs, but these usually fail to survive long. After the larva has gained entrance to the soft bark of the tree it feeds greedily and grows rapidly, and in the course of a few weeks has become of sufficient size to do material damage.

The number of larvæ which may infest a single tree is often surprising, and it is a matter of wonder that trees so infested are not completely killed within a season. The average number of larvæ to a tree in orchards varies widely according to region, in some sections there being only 2 or 3, whereas in other regions some 8 or 10 borers are usually present. In extreme cases 40, 60, and even 90 borers have been found infesting the roots and crown of individual peach trees 6 or 7 years old.

There is only one generation a year. The larger borers pass the winter in their burrows in the bark, though many of the smaller ones construct a cell, or hibernaculum, outside of the burrow on the bark of the tree. Feeding is active from early spring until late fall and, in the South, also during warm

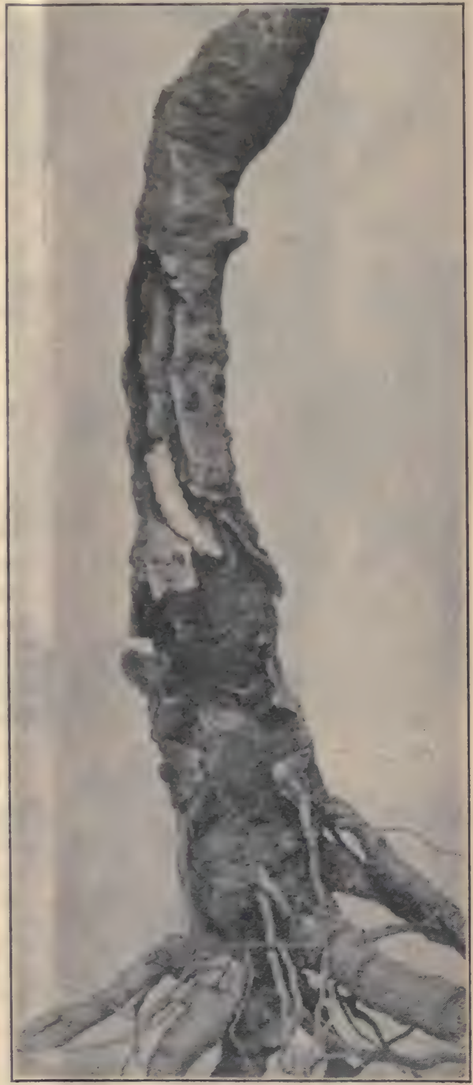

FIG. 2.—Young peach tree practically girdled by the peach borer.

periods in the winter. Larvæ varying from quite small to nearly full grown are to be found in the trees during summer; during late spring, however, they are more nearly of full size. The mature peach borer (fig. 5) is about an inch long, yellowish-white, with dark reddish head. On the body are a few brownish hairs arising from tubercles.

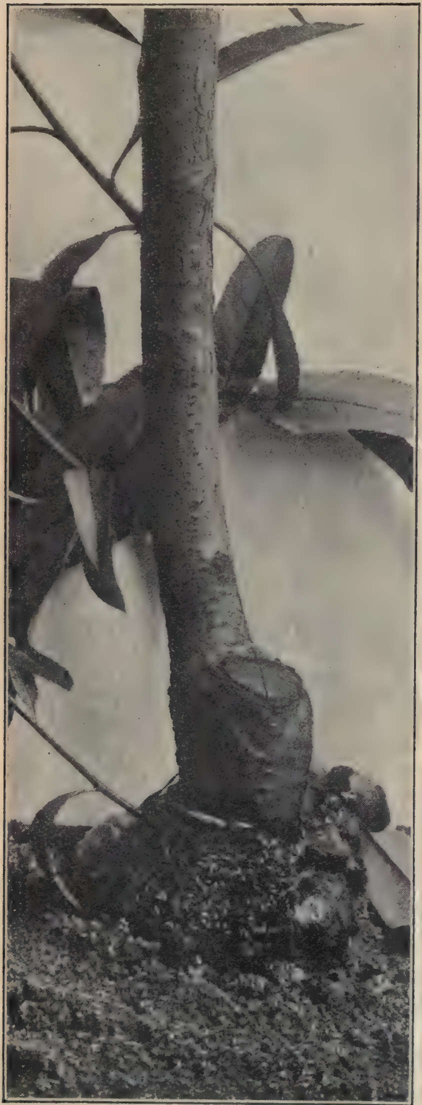

FIG. 3.—Gum and frass exuding from base of peach tree, the usual sign of infestation.

THE PUPA.

The peach borer, when full grown and ready to change its form, incloses itself in a cocoon composed of silk, in which are incorporated particles of bark and excrement, forming a tough, brownish, capsule-like structure. The cocoon (fig. 6) is usually constructed at the head of or somewhat beyond the larval burrow, and, owing to its similarity in color to that of the bark of the tree, it is often overlooked by orchardists. Borers infesting the roots some inches from the base of the tree may work directly upward to the surface of the soil and there construct their cocoons. Sheltered within the cocoon the larva changes to a pupa, or chrysalis. The pupa (fig. 7) is about three-fourths of an inch in length, brown, and provided with stiff spines on the back to assist it in working itself out of the cocoon, thus facilitating the escape of the moth. Within three or four weeks the pupa is fully developed and wriggles out of the cocoon, the emerging moth leaving the empty skin protruding more than halfway from the cocoon (fig. 6).

THE MOTH.

The moths of the peach borer are beautiful clear-winged insects, the male differing strikingly from the female in markings. In the male (fig. 8) the wings are transparent, with steel-blue trimmings along the margin and veins, and the abdomen is marked with narrow yellow bands, quite conspicuous on the steel-blue ground color. The female (fig. 9) is steel-blue, with opaque forewings, and there are one or two orange-colored bands around the abdomen.

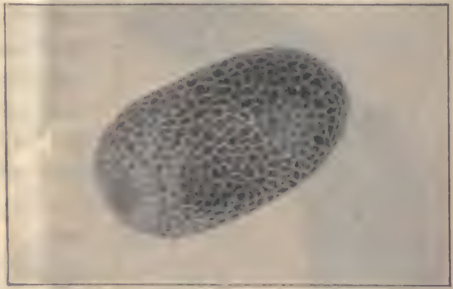

FIG. 4.—Egg of the peach borer moth. Considerably enlarged.

The adults are day fliers and, owing to their general resemblance to wasps when on the wing, are at times mistaken for these. Very soon after emergence mating takes place and oviposition begins. It is doubtful whether the moths feed to any extent during the course of their lives, and within a few days the eggs have been deposited and the moths have died.

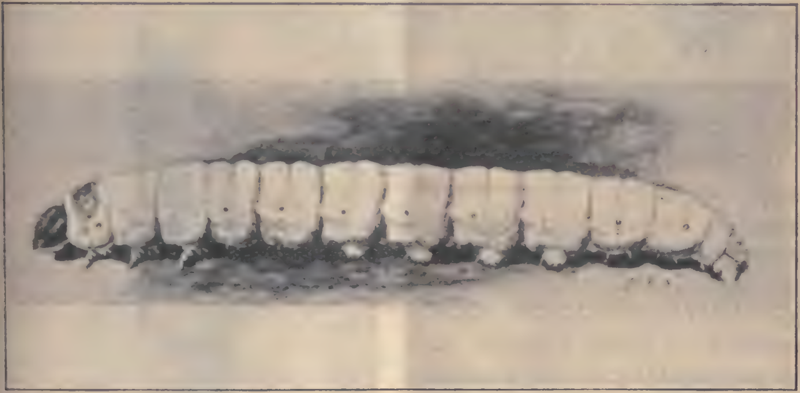

FIG. 5.—The peach borer. Enlarged.

HOW TO CONTROL THE PEST.

Many methods of control of the peach borer have been proposed during the more than 150 years that this pest has been known to injure the peach. Horticultural literature contains numerous accounts of the experience of growers with this or that wash or method of treatment of the borer, and entomologists, during the last 20 or 30 years, have given much time to discover, if possible, ways and means of preventing or reducing its injuries. While some of the washes and procedures recommended undoubtedly have reduced infestation, they have not afforded the trees adequate protection. Commercial peach growers for the most part have depended upon "worming" the trees. A few use a wash on the trunk after worming, or mound the earth around the trees, or do both, but the great majority have followed no other method than worming the trees in the fall or spring, the more careful growers worming during both seasons.

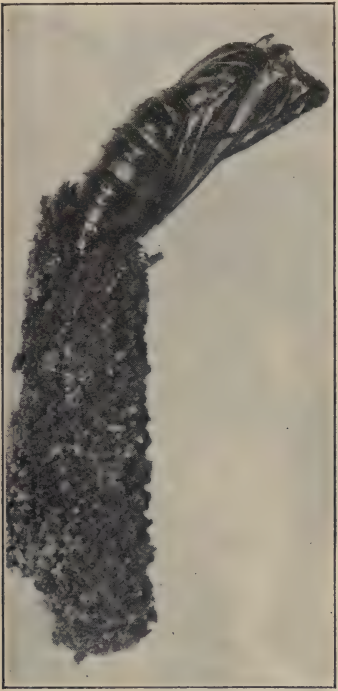

FIG. 6.—The peach borer cocoon and empty pupal skin. Enlarged.

Worming of peach trees has always been a bugbear to the commercial orchardist. It is a disagreeable and arduous task and likely to be slighted by the worker. Unless done conscientiously and thoroughly, with due care to remove all borers and not to injure the trees, worming is of questionable expediency. A decidedly better method of borer control, especially valuable for commercial growers, has been developed by the Bureau of Entomology and is described on pages 10–14. Careful worming of trees, however, may be preferred by some, especially where only a few trees are involved, as in small home orchards.

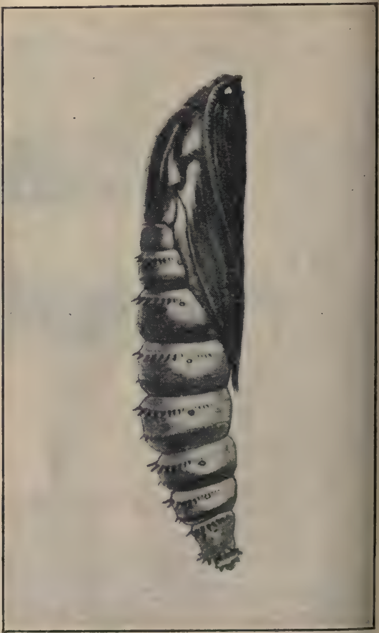

FIG. 7.—Pupa of the peach borer. Enlarged.

"WORMING."

Previous to worming, the earth should be removed from around the crown of the tree to a depth of 4 or 5 inches, and, if feasible, the trunk brushed or scraped to remove loose bark and dirt. With a little experience the worker can readily locate the borers in their burrows and remove them by means of a knife or other suitable tool. In worming care should be taken not to cut the sound bark more than necessary, and the cutting should be done vertically. Carelessness in the use of worming tools may result in as much damage to trees as that caused by the insects. After trees have been wormed it is desirable, if practicable, to go over them again a few days later, when the location of any larvæ missed during the first examination will usually be indicated by the exuded excrement or frass. When the worming has been completed the earth should be replaced around the trees—in the fall, always before freezing weather sets in.

After spring worming, a wash can be applied, or the earth mounded somewhat around the base of the tree, or the wash and mound may both be used (fig. 10). There is little if any advantage in the use of a wash, or in mounding, after the fall worming, since infestation occurs during the summer and early fall. The mounding will cause the borers to enter the bark somewhat higher, facilitating their detection and removal. If washes or wrappings are to be used they should be put on at once after the spring worming and before the earth is replaced around the trees. Perhaps as good a wash as any can be made from lime-sulphur concentrate (33° Baumé), used at the rate of 1 part to 6 or 7 parts of water, to which an amount of lime has been added to give it the consistency of heavy paint. A caustic wash can sometimes be used to advantage in the fall to destroy any little borers more or less exposed on the tree. For this purpose use caustic soda or lye at the rate of 1 pound to 8 or 9 gallons of water, and to this, after careful slaking, add about 10 pounds of stone lime.

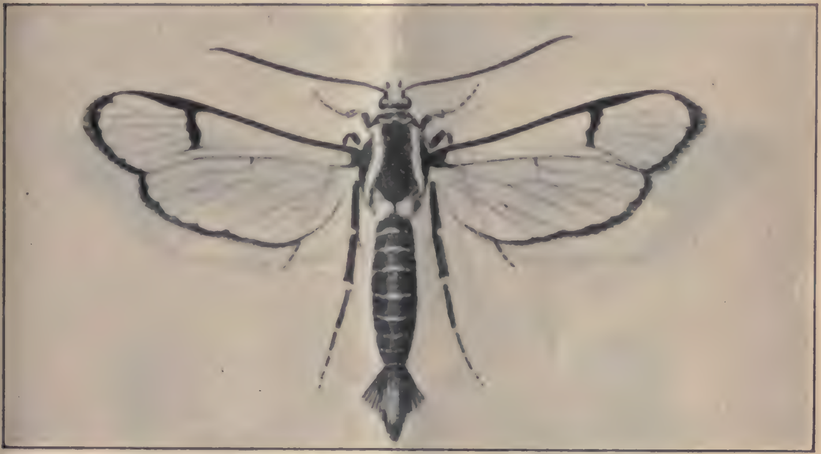

FIG. 8.—Adult male of the peach borer. Enlarged.

THE PARA-DICHLOROBENZENE TREATMENT.

In 1915 the Bureau of Entomology began experiments in the use of various toxic gases as a possible means of control of the peach borer. This work, carried out by Mr. E. B. Blakeslee and continued for several seasons, covered a wide range of soil, climatic, and seasonal conditions, and demonstrated the usefulness for borer control of para-dichlorobenzene and the impracticability of using carbon disulphid, sodium cyanid, and certain other materials. Many experiments with para-dichlorobenzene showed that when properly used it is uniformly effective in killing a high percentage of the borers without injurious results to trees 6 years of age and over. The results were published in United States Department of Agriculture Bulletin No. 796 (Oct. 21, 1919), and resulted in the prompt adoption of the treatment by many commercial peach growers. There has now been accumulated a sufficient body of experience, based on large-scale commercial use, and further experiments by the bureau and others, principally the New Jersey Agricultural Experiment Station, to show that a practical economic method of control has been found for this heretofore almost invulnerable pest.

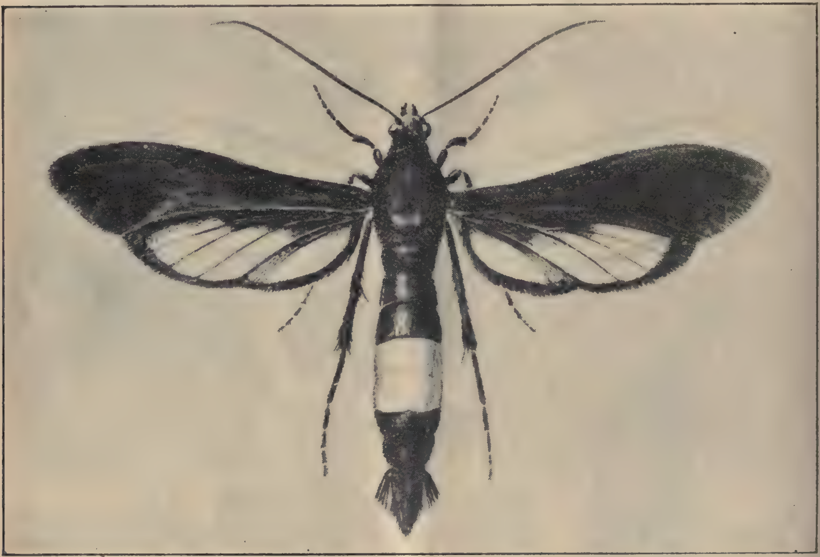

FIG. 9.—Adult female of the peach borer. Enlarged.

PARA-DICHLOROBENZENE DESCRIBED.

Para-dichlorobenzene, for which the abbreviated name "paradichlor" is suggested when referred to as an insecticide, is a white crystalline substance having an etherlike odor, and vaporizing readily under favorable conditions. The vapor, while harmless to persons and domestic animals under ordinary conditions, is poisonous to insects confined in its fumes for a sufficient length of time. Its vapor is heavier than air and readily permeates the soil. The chemical is, for practical purposes, noninflammable, and the fact that it is a finely divided solid adds much to the ease with which it may be applied. As usually sold it is a little too coarse for rapid volatilization, and orchardists in purchasing it should specify that they be furnished with a grade of the fineness of granulated sugar or coarse salt. Only the pure article should be purchased. Should there be some loss by evaporation in the containers the remainder of the chemical is always 100 per cent pure. If mixed with some inert material, the loss by evaporation of the "paradichlor" will result in a weakened mixture difficult to employ at a known strength.

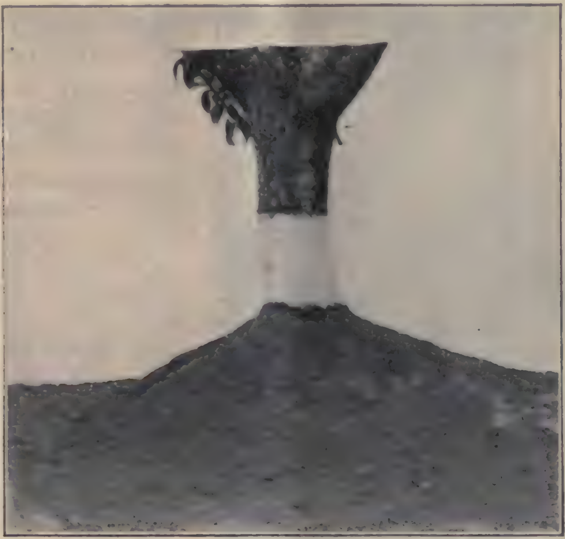

FIG. 10.—Peach tree to which a wash has been applied and earth mounded around the base.

WHEN TO APPLY IT.

The application of "paradichlor" to peach trees for the control of the peach borer should be made in the fall, after most of the moths have oviposited, to avoid late infestation of the trees. At this time many of the larvæ are still small and more or less exposed, and hence more susceptible to the gas than if deep in their burrows on the crown and roots. Applications must not be delayed, however, until the soil temperature is so low that proper volatilization of the chemical will not result. Many studies have been made as to the soil temperature conditions best for the application of "paradichlor" and the following dates tentatively decided upon as best on the average for the respective regions:

Michigan, Ohio, Connecticut	September 1.
New Jersey, West Virginia, Maryland	September 10.
North Carolina and the Ozarks	September 25.
Georgia and Texas	October 10.

There are, however, limited seasonal variations in time of cessation of egg laying by moths in the fall. If applications of "paradichlor" are made as indicated, any belated young larvæ as they hatch will be killed for the most part during the continuance of the chemical around the trees—a period of several weeks—and beyond this time not much, if any, infestation will occur.

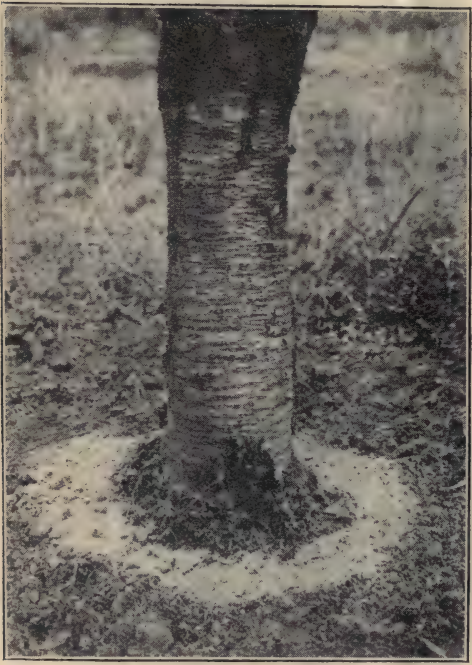

FIG. 11.—Preparation of ground previous to applying paradichlorobenzene and method of application of the chemical.

PREPARING THE TREES.

The earth for 15 or 18 inches around the base of trees should be cleaned of grass and weeds and leveled off, without, however, digging up the soil any more than necessary to break the surface crust (fig. 11). If borers are present in the trunk of the trees somewhat above the ground level, as indicated by the presence of gum or frass, a few shovelfuls of earth should be thrown around the tree and leveled off to form a bed for the application of the "paradichlor" high enough to subject the infested trunk to the fumes of the gas. As a rule the raising of the soil level around the tree will be unnecessary and is undesirable as favoring the washing down of the mounds by rain and interfering with the effectiveness of the treatment. If there is a decided mound of earth around the collar of the tree, this should be scraped down level with the surrounding soil. Excessive gum and frass should be removed and the bark lightly scraped. Exposed roots should be covered with a light layer of soil, since these are less resistant to gas fumes than the bark of the trees.

APPLYING THE "PARADICHLOR."

After the soil around the base of the tree has been prepared the "paradichlor" is applied evenly in a circular band an inch or two wide entirely around the tree, care being taken that the inner part of the band is about 2 inches from the tree trunk (fig. 11). Use 1 ounce per tree, by weight, or somewhat more for very large trees, and for convenience in measuring the chemical a small bottle or wooden or tin box holding just the desired amount may be employed. As soon as the chemical has been applied, cover it carefully with several shovelfuls of dirt, making a cone-shaped mound around the tree trunk by packing the earth with the back of the shovel (fig. 12).

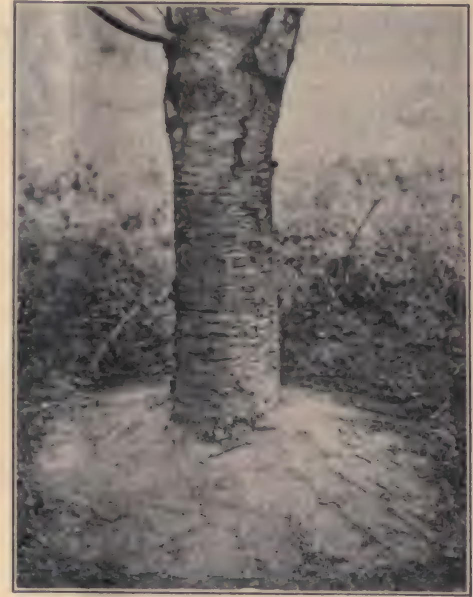
FIG. 12.—Earth mounded around the base of peach tree to cover the para-dichlorobenzene.

IMPORTANT POINTS TO REMEMBER.

Under average fall weather conditions, with soil temperature around 60° F., or higher, most of the "paradichlor" under the soil covering will have evaporated in four to six weeks, killing from 90 to 100 per cent of the borers. Cooler weather than this, and frequent rains which keep the soil more or less wet, will greatly retard evaporation of the "paradichlor." Under these conditions, and in general practice if feasible, mounds should be removed some five to six weeks after application of the chemical, so as to avoid subjecting the tree further to the gas on account of danger of injury. From present knowledge, orchardists are taking undue risks, especially in case of applications later than above indicated, in allowing the mounds to remain around the trees over winter—a practice that has been frequently observed. Labor arrangements should be made to put on the chemical at the right time for its proper evaporation. In large commercial operations the work could well be divided into sections, with the necessary number of men in each section, under a competent foreman, to carry it along expeditiously. One group of men could prepare the trees for the "paradichlor," another group apply the chemical, and the third group follow immediately to cover and mound the trees.

DANGER OF INJURING TREES.

Most materials effective in killing insects will also injure trees when used in large dosages. In the successful use of insecticides it is necessary to ascertain the minimum amount which will kill the insect and which will not injure the plants treated. Para-dichlorobenzene is a good example of such a chemical where the margin of safety is adequate for its practical employment as an insecticide, but where care on the part of users must always be employed. Close adherence to the directions given, as to the time, method of application, and dosage, is urged upon the users of the "paradichlor" method of peach-borer control. In the experiments of the Bureau of Entomology when so used, no injury has been noted to trees 6 years of age and over, and its use on trees younger than this is not recommended.

How To Do It

DO YOU want practical suggestions on how to build a silo, a hog house, a poultry house, a potato-storage house, or how to make a fireless cooker, or other farm home convenience? Are you seeking ideas on how to prepare vegetables for the table, how to care for food in the home, how to bake bread and cake and other appetizing foods in an efficient and economical manner? Is there some practical question about your corn or wheat or cotton or other crops, or about your poultry or live stock, to which you are seeking an answer? The answers to thousands of such questions and practical suggestions for doing thousands of things about the farm and home are contained in over 500 Farmers' Bulletins, which can be obtained upon application to the Division of Publications, United States Department of Agriculture, Washington, D. C.

FARMERS' BULLETIN 1247
UNITED STATES DEPARTMENT OF AGRICULTURE

AMERICAN MOLES

AS AGRICULTURAL PESTS AND AS FUR PRODUCERS

MOLES have been dealt with in the United States chiefly as a nuisance, but in some European countries they are trapped extensively not only to be rid of them as a pest but also to harvest their pelts. Millions of European moleskins have been used by fur manufacturers in this country and until recently have furnished the sole supply. The fact that the skins of some American moles, especially those found in western Washington and Oregon, are larger and have better texture than those from Europe has been recognized, and there is now a demand for American moleskins by some important American fur dealers. The pelt of the common mole of the Eastern States, though smaller, is about the same quality as that of the European species, and if collected in sufficient numbers to create a demand might be marketed at a slight profit. The propagation of moles for their fur, however, is impracticable.

All species of moles live chiefly upon earthworms and insects that inhabit the ground. To the extent that they destroy insects they are beneficial to the farmer; but they often work in lawns and newly planted gardens, doing considerable damage by heaving up the soil and undermining tender plants. While all are undesirable in such places, no general warfare against an unobjectionable insectivorous mammal should be encouraged.

There is now a steady demand in the fur industry for American moleskins, and the development of a market for them will stimulate trapping. This is especially desirable in localities where moles are troublesome.

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E. W. NELSON, Chief

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AMERICAN MOLES AS AGRICULTURAL PESTS AND AS FUR PRODUCERS.

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WHERE MOLES ARE FOUND.

WITHIN the boundaries of the United States there are recognized five groups of true moles. Two of these are confined to the Pacific coast and three are distributed over the section mostly east of the one hundredth meridian, extending from Canada to the Gulf of Mexico (see map, fig. 1). No moles are known from the Great Basin and the Rocky Mountain regions, and their range is very restricted on the Great Plains. The common mole of the eastern United States[1] may be found almost anywhere south of New England, New York, Michigan, and central Minnesota, except in the mountain regions. In the latter districts and in the greater part of Pennsylvania, New York, New England, and to the northward, the common mole is replaced by the star-nosed mole[2] and the Brewer mole.[3] The Townsend mole[4] of the Pacific Coast States is the largest of its kind on the continent and is more abundant locally than

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[1] *Scalopus aquaticus.*

[2] *Condylura cristata.*

[3] *Parascalops breweri.*

[4] *Scapanus townsendii.*

NOTE.—This bulletin treats of moles occurring throughout the United States and supersedes Farmers' Bulletin 583, which deals with the habits of eastern species, and Farmers' Bulletin 832, which treats chiefly of trapping western forms for their fur.

any species of mole occurring elsewhere. The Gibbs mole,[5] another west-coast form, is so rare as ordinarily to escape notice.

The general distribution of the mole seems to depend very largely upon atmospheric humidity and the resulting condition of the soil. Moles are absent altogether from our arid regions, and where the prairies of the Middle West merge gradually into the Plains the animals are found only along water courses. In these regions of deficient rainfall the ground is so dry and hard the greater part of the year as to be wholly unsuited to the existence of earthworms and the various insect larvae upon which the mole depends for subsistence. In the East the mole is most abundant in moist, rich soils along streams, particularly if these situations are somewhat shaded. In the cooler, more uniform climate of the Northwest coast region moles are plentiful anywhere in the well-watered valleys.

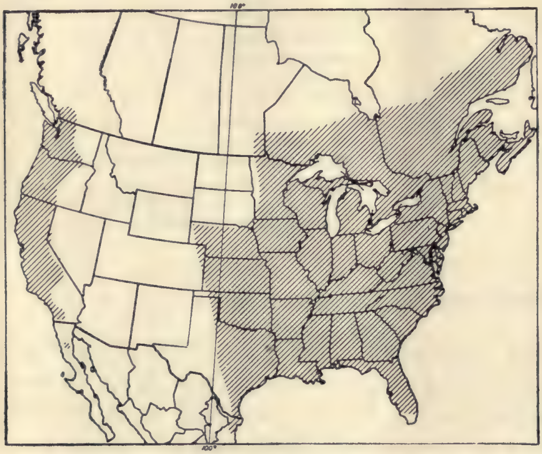

FIG. 1.—Distribution of moles in North America. The Pacific coast area includes the ranges of the Townsend and Gibbs moles (*Scapanus* and *Neurotrichus*); in the eastern area are the common mole (*Scalopus*), the star-nosed mole (*Condylura*), and the Brewer mole (*Parascalops*).

DESCRIPTION.

So seldom is the mole seen, even by those who are familiar with its work, that it is often confused with other small creatures, particularly the shrew, the vole (or meadow mouse), and the pocket gopher. The cheek pouches of the pocket gopher readily distinguish it from the sightless mole. The mole is not a rodent, and can be readily distinguished from any of these and from the shrew by its short, stout front limbs, ending in broad, rounded hands with palms turned outward; it has a rather elongated body, close plushlike fur, a pointed snout, and a short tail (figs. 2 and 3). Neither external eyes nor ears are ordinarily in evidence. If not totally blind, the common mole of the eastern United States can at best merely distinguish between light and darkness, as what remains of its organs of sight lies wholly beneath the skin. Degeneration of these organs has apparently not proceeded so far in the Townsend mole, which usually opens its eyes when annoyed by an observer.

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[5] *Neurotrichus gibbsii.*

HABITS.

The mole lives mostly underground. Such experiences as fall to its lot must necessarily come through its sensitive touch, acute hearing, or highly developed powers of smell. While the animal is seldom seen above ground, it sometimes ventures out of its tunnels, perhaps chiefly at night, since skulls and other remains of moles are occasionally found about the nesting places of owls.

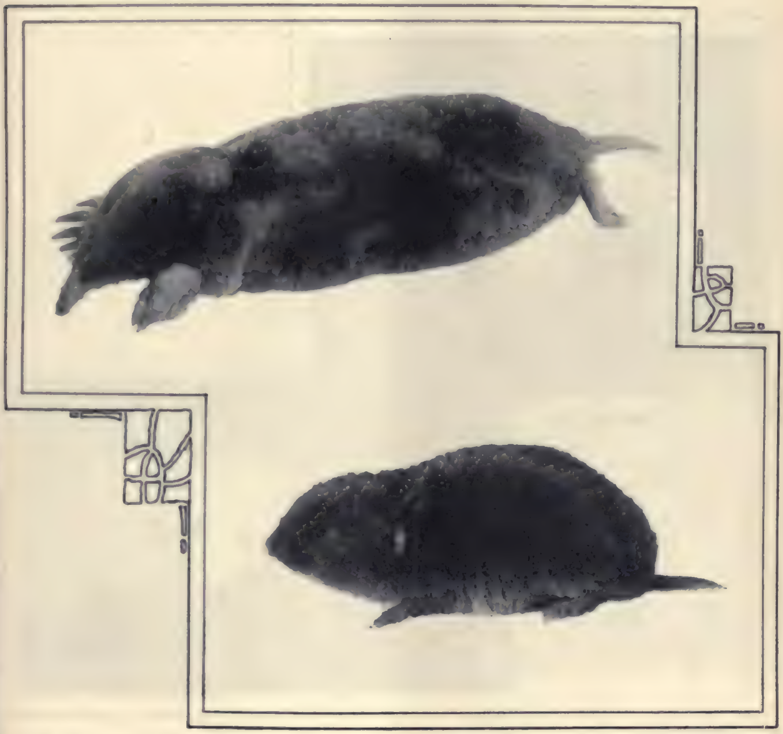

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FIG. 2.—Comparison of mole and a member of the rodent order (pine mouse). Broad, rounded hands turned outward, pointed snout, and practical absence of eyes serve to distinguish the mole from mice, rats, and other rodents.

RUNWAYS AND NESTS.

When a mole is living in lawns, gardens, or fields, it is not adept at concealing the evidences of its presence. Telltale ridges (see itle-page illustration) or conspicuous mounds (fig. 4) of earth plainly indicate the runways. The ridges show the direction and course of the animal's hunting paths, which are so close to the surface that the sod or the soil crust is raised. The mounds indicate deeper tunneling, for they are formed of earth pushed up from lower workings, where the soil is too compact to be simply crowded aside. Such mounds thickly dot the mole-infested areas of the Pacific coast country, but are of much rarer occurrence in the habitat of the eastern species.

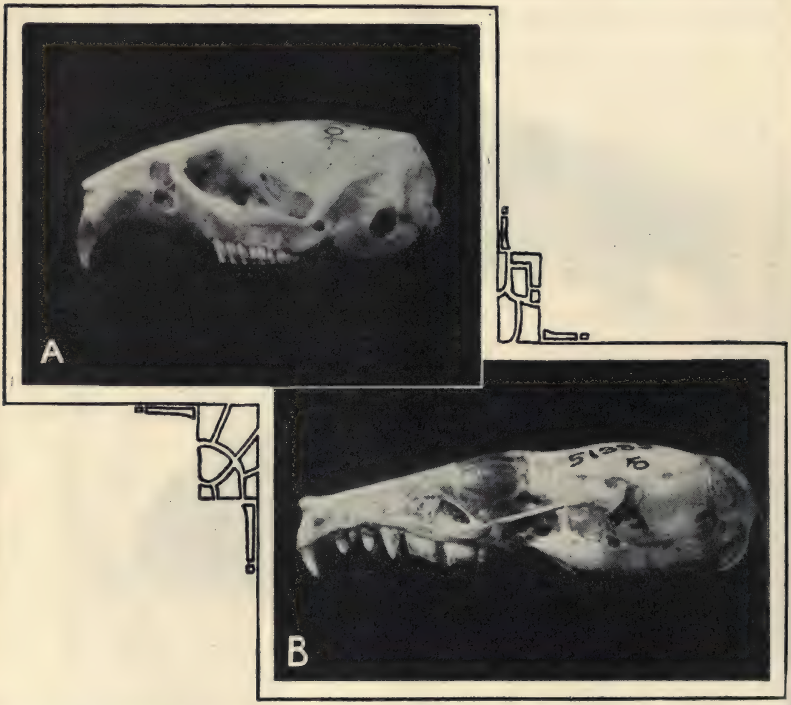

FIG. 3.—Difference in shape of head and arrangement of teeth in moles and in rodents is readily observed in these typical skulls. (*A*) Skull of field mouse (*Microtus*, N. M. 30424); (*B*) skull of mole (*Scalopus*, N. M. 51385). Both are enlarged to twice natural size.

The mounds of the Townsend and other moles of the west coast resemble superficially the earth heaps thrown up by pocket gophers, but usually they can be distinguished from the latter by even casual inspection (fig. 5). The mole heaps are the more rounded and symmetrical and are built up, volcano fashion, by successive upheavals beneath and through the center of the pile, the soil, in compact little masses, rolling down the sides from the summit. The pocket gopher, on the other hand, brings up the soil excavated in its workings and dumps it on the surface in armfuls, thus forming low, semicircular, or fan-shaped accumulations of fine dirt more or less to one side of the burrow exit.

The more permanent tunnels of the mole commonly run along fences, hedges, walks, plant rows, and the ridges of open fields. Such situations are the more frequented by the mole because they offer some concealment or shelter and are less often disturbed by the activities of man. These burrows vary in depth from 2 or 3 inches to levels beneath the reach of the plow. They constitute a labyrinth of runways, constructed with apparently no definite plan and including here and there an enlargement. One or more of these enlargements may, especially in the breeding season, contain a nest of half-dried grass or of grass and dead leaves.

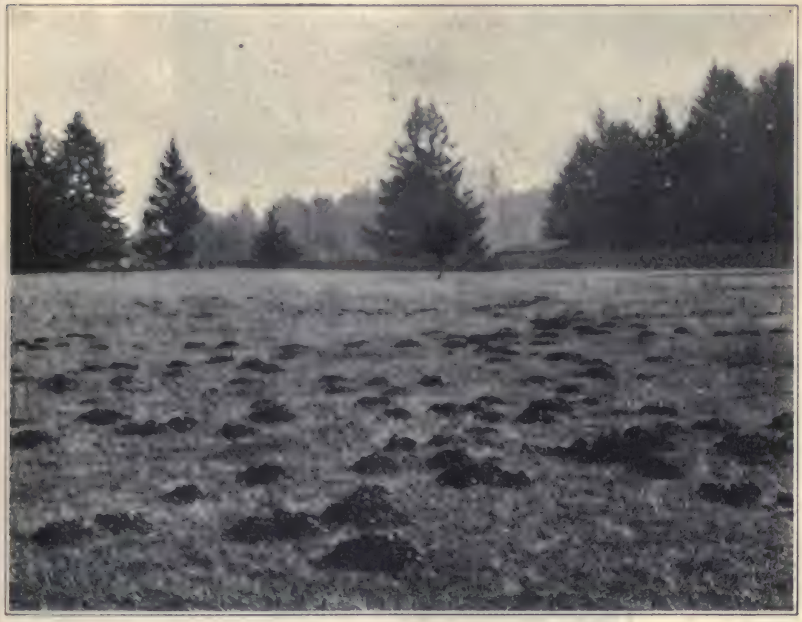

Fig. 4.—Mounds characteristic of moles in the Pacific coast region (see also fig. 6). These thickly dot the areas infested by the Townsend mole in Washington and Oregon. They are not usually found in areas frequented by eastern moles.

Certain galleries or passages leading out from the deeper central system trend upward here and there to join the shallow subsurface runs that stretch out over the mole's hunting grounds (fig. 6). Through these runs, the little animal hurries along at irregular intervals in search of food and, when occasion demands, extends the limits of its operations by pushing out into untouched soil.

As it extends the subsurface runways the movement of the mole is almost literally one of swimming. With powerful action of the heavy shoulder muscles the hands are brought forward, palms outward, until they almost or quite touch in front of the snout. They are then thrust outward and backward to push the soil aside, while the body follows in the passageway thus created. The snout is a sensitive organ of touch and is not used for rooting.

ACTIVE PERIODS.

It is commonly believed that the mole works only at regular periods each day—morning, noon, and evening, as most frequently alleged—but direct observations fail to show that there is any one time of day when it is more active than at others. If an opening is made into a mole's runway the little animal will invariably repair the breach when it next comes that way (fig. 7). By taking advantage of this habit one can gain much information if he will visit, at short intervals through the day, each of a number of runs in which a small break has been made. In an experimental way a large number of

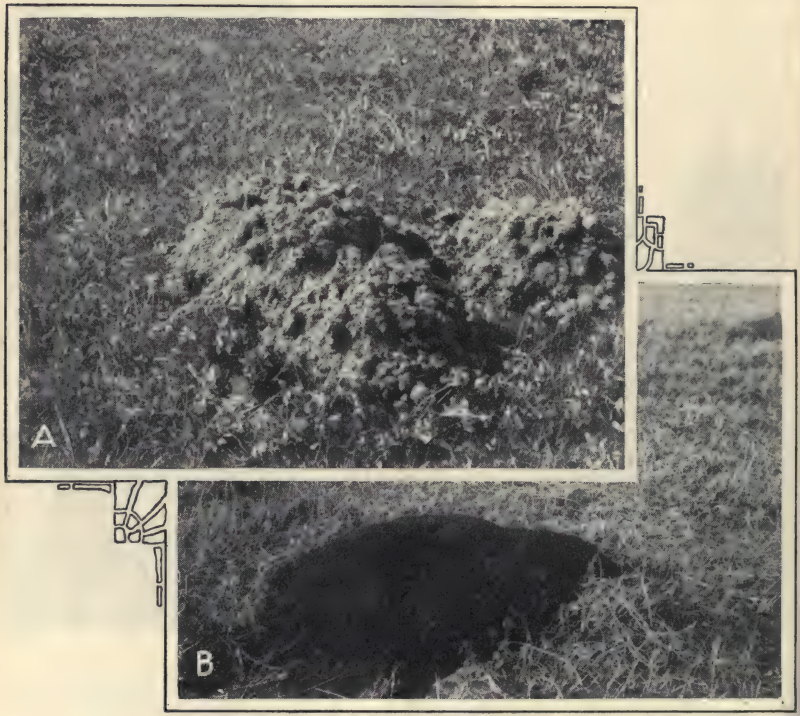

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FIG. 5.—(*A*) Mound of western mole contrasted with (*B*) mound made by pocket gopher. The former is the more symmetrical, being built up volcano fashion by upheavals through the center. The latter is fan shaped, thrown out to one side of the burrow exit.

runs have thus been kept under observation for periods of several days at a time, with results indicating that moles are as likely to be found working at one hour of the day or night as at another. This is especially true at seasons when there is no great variation in temperature throughout the period of 24 hours.

As to seasonal activity, it may be said that moles are probably never dormant, that they never hibernate. They may be trapped at any time of year when the ground is not frozen too hard to permit the working of the trap. It must be understood, however, that extension of surface runways occurs mainly at times when soil conditions are favorable—after rains in summer or during periods of thaw in winter. At other times in its search for food the mole must use its old runs or work at depths and in situations unaffected by frost or drought. Movements of soil-inhabiting worms, insects, and larvae tend to bring ever fresh supplies of food into these tunnels.

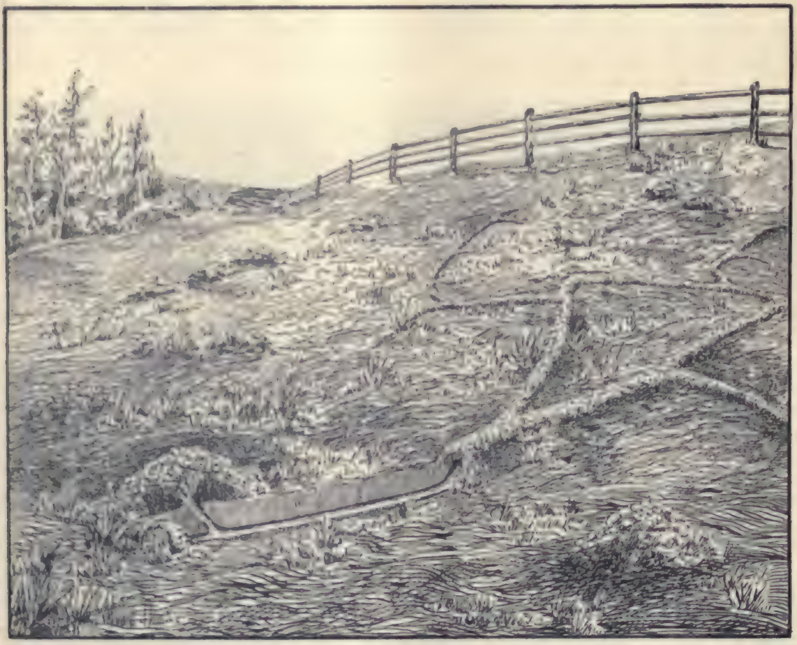

FIG. 6.—Mounds and ridges of earth similar to those shown in figures 4 and 5. A sectional view of part of a deeper runway connected with mound and with subsurface hunting path is shown. Traps give best results when on these main tunnels.

BREEDING HABITS.

Contrary to popular opinion, moles are slow breeders. Their life of seclusion shelters them from many of the dangers that constantly threaten the existence of the small mammals living above ground.

To maintain their normal numbers from generation to generation a rapid rate of increase, therefore, is not necessary. The young are brought forth early in spring in rudely constructed nests of half-green grass stubble and rootlets. The number in a litter is commonly three in the case of the Townsend mole and four with the common eastern mole (fig. 8).

Moles grow and develop with astonishing rapidity. In the Puget Sound country most of the young are born in the latter half of March and spend the month of April in the nests. By the last of May they are so well grown that the ordinary observer would not be likely to distinguish them from the parent moles. This rapid growth accounts for the fact that a really small young mole is seldom, if ever, trapped. By the time they leave the home nest and take to the runways for themselves they have already attained something like the proportions of adults.

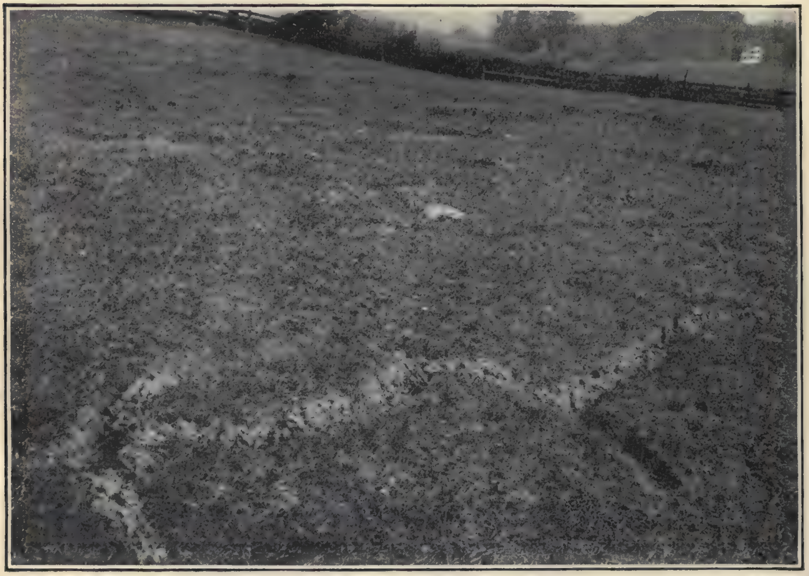
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FIG. 7.—The mole's method of repairing runways. Lower right-hand fork not repaired.

NATURAL FOOD.

A mole's appetite seems to be almost insatiable. When held in captivity and given food to its liking, it will sometimes eat more than its own weight in a day. The large quantity of food thus required is no doubt due to the intensely active life the little animal leads. Perhaps no other mammal is relatively so strong or does so much hard work in a day.

The character of the food has been the subject of much discussion, but the multiplied evidence of digestive tract, dentition, stomach content, and choice of food when in captivity leaves no doubt that the mole is a carnivorous animal, though vegetable matter is sometimes found in its stomach. An examination of 200 stomachs of the common eastern mole, taken in all months of the year, demonstrated that earthworms and white grubs constitute the bulk of the food. Beetles and their larvae and other insects that enter the ground, spiders, centipedes, cocoons, and puparia also form a portion. In one stomach were found the remains of 171 small white grubs, in one 250 ant puparia, in one 10 cutworms, and in another 12 earthworms. The last-named item forms the great bulk of the food of the moles of the Northwest coast country, for the soil there fairly teems with earthworms, while ground-inhabiting insects and larvae are comparatively scarce. The presence of more or less starchy material in the stomachs of some moles is proof that the little animal occasionally varies its worm and insect diet with some vegetable food. Seed coats of peas, corn, wheat, oats, and peanuts have been identified in a few stomachs. In captivity moles ravenously eat beefsteak, flesh of birds, fish, or almost any sort of fresh meat, but starve to death when supplied with nothing other than grain and root crops.

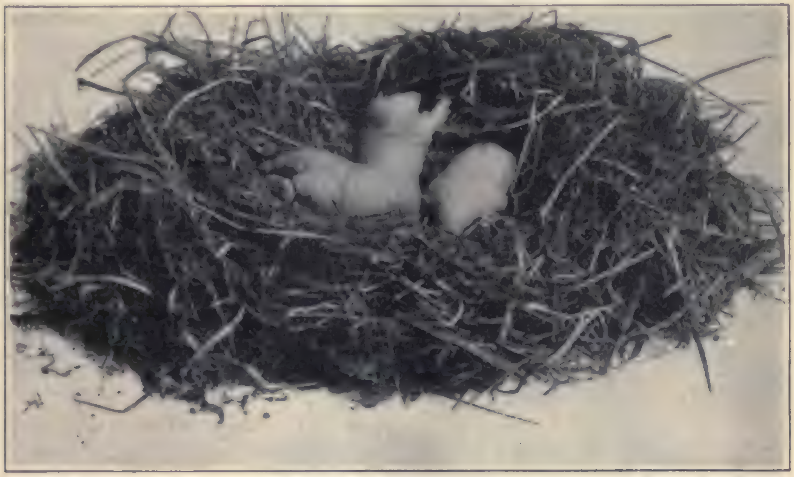

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FIG. 8.—Young of the Townsend mole in nest removed from underground chamber. The eastern mole averages about four to the litter. The number in the litter of the Townsend mole is commonly three, as here pictured.

DAMAGE BY MOLES.

From the standpoint of food habits it would seem that moles are chiefly beneficial to our interests, or at least neutral. It is probably true, though, that the large Townsend moles of the Pacific coast have acquired the habit of foraging in gardens to a greater extent than the common moles of the Eastern States. The proofs that they destroy sprouting corn and peas and newly forming bulbs and root crops are direct and final. The gnawing and hollowing out of mature bulbs and tubers, however, is not the work of moles but of the rodents that trespass in their runways. The mole is not a rodent and is badly handicapped for gnawing by its projecting snout, which extends nearly a half inch ahead of the small incisor teeth.

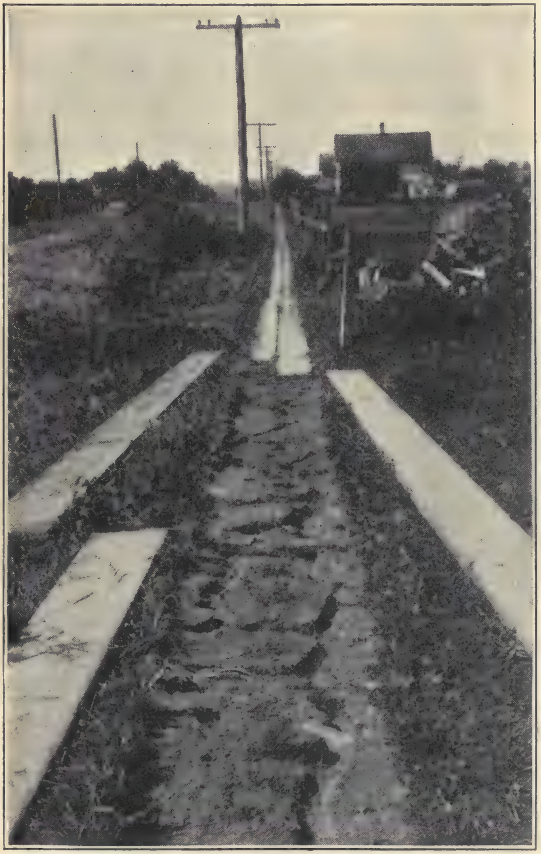

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FIG. 9.—Mole runways under sidewalk. From such shelter and nesting places moles run riot in adjacent gardens, lawns, and parks.

It is common knowledge that in certain situations moles become an intolerable nuisance from their habit of upridging the sod, throwing up mounds, tearing up the roots of plants, displacing bulbs, and creating general havoc in gardens, lawns, and parks. In meadows and grain fields, too, the mounds are objectionable, not only by reason of the growing crops they cover, but also because of the obstruction they offer to the use of machines in mowing or harvesting. The presence of moles in some of these situations may be evidence of heavy infestation of the soil by white grubs or other insect larvae, but the case in point is only another illustration of the old saying that the remedy may be worse than the disease.

In the valleys of the Northwest coast region moles infest farm premises and towns much as rats do similar situations there and elsewhere in the country. They find shelter and dry places for nesting under sidewalks (fig. 9), sheds, poultry houses, porches, and even dwellings. From these harbors they run riot over the premises.

NATURAL ENEMIES AND CHECKS.

On account of its secluded life the mole is little subject to attacks by the many foes of other small mammals. Its burrow is so small that no formidable enemy except perhaps the weasel or the snake can follow it underground, and as it seldom leaves its passageways there is little chance of its being seen by predatory animals. However, the movement of the soil when a mole is working near the surface may readily be detected by a watchful foe, and it is probable that hungry denizens of the wild secure a morsel of food now and then by springing suddenly upon a disturbed spot of earth and hurriedly digging out the furry little miner. But there is good evidence that moles are distasteful to some animals at least, if not to all, for they are seldom eaten by the domestic cats and dogs that have learned to catch them. The peculiar rank odor of a mole may account for its not being relished. It is quite likely, also, that the dense, soft fur is objectionable to some animals.

Among birds of prey, the hawks and owls take only a small toll from the mole tribe. An examination of the stomach contents of over 2,000 of these birds disclosed the remains of only 13 moles.[6] Five of these had been eaten by the red-tailed hawk, 4 by the red-shouldered hawk, and 1 each by the broad-winged hawk, the barred owl, the great gray owl, and the screech owl. Of 3,005 skulls of small mammals found in pellets disgorged by the barn owl, only 2 were of the mole.

Occasional or periodic floods which spread over lowlands adjoining streams constitute one of the greatest checks to the inordinate increase of moles. During these inundations large numbers of moles may be found congregating on elevated knolls and ridges or clinging to drift masses lodged against various obstructions. Even though these individuals survive, their young have probably perished, for it is in the breeding season that the freshets commonly occur. It has been noted, too, that heavy rains at this season drown some of the young in the nests.

TRESPASSERS IN MOLE RUNWAYS.

The mole is not permitted to enjoy undisputed occupancy of the underground galleries which its industry has constructed. Certain other small mammals, particularly shrews, voles, or meadow mice, and sometimes ordinary house mice, rats, and pocket gophers, find these tunnels convenient highways for traffic and marauding. As a result of this trespassing the reputation of the mole suffers, for most of the injury to seed grains, tubers, and roots of cultivated plants is directly chargeable to these intruding rodents. A study of tooth marks on the damaged products or the systematic trapping of the intruders will bear out this statement. In the East, Middle West, or Far West, wherever a count is made of the occupants of mole runs, the trespassers are usually found to be much more numerous than the moles themselves.

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[6] Fisher, A. K., Hawks and owls of the United States in their relation to agriculture: Bull. 3, Div. Ornithology and Mammalogy, U. S. Dept. Agr., 1893.

CONTROLLING THE MOLE.

Experience in dealing with the mole problem over many years shows that it is impracticable to poison these little animals or to combat them successfully in any way except by the use of the trap. The very nature of their food makes it difficult to secure an acceptable substitute for the living grubs, worms, and insects upon which they feed. Then, too, they seem shrewd and quick to sense the danger in poisoned substances.

They may be driven from certain parts of their burrows by introducing substances that are ill smelling or in other respects offensive or injurious to them; but this is only temporizing with the evil and not getting rid of it. One may occasionally drown out a mole by the use of a garden hose, but in this there is the risk of leaving parts of the lawn or garden boggy. Gases introduced into the runways by specially designed pumps, by the evaporation of liquids on wads of absorbent material, or by the burning of "cartridges," do not always reach that part of the burrow where a mole is located and whence it is unable to escape. Such gases are usually dissipated in the loose soil at points where the runways are near the surface.

WHERE TO TRAP.

As stated in the discussion of runways and nests, the signs of a mole's presence and activity are not hard to discover; the earth ridges and mounds are only too conspicuous. The path on which the trap must be set is thus located. For the moles east of the Rockies dependence must usually be placed on trapping in the hunting paths marked by the ridges. Trapping on the Pacific coast is attended with better success when the deeper runways indicated by the mounds are selected for the scene of operations.

Many of the deeper runs of the mole are highways of common traffic, used often by a number of individuals, and frequented also, as previously stated, by shrews and certain species of small rodents. Good catches usually may be expected from continued use of traps in these highways, particularly when they run along fence lines or ridges in the open fields, or cross from sod into cultivated ground. In such situations a dozen to twenty or more moles are not infrequently taken in the course of a few weeks by resetting the trap day after day at the same spot (fig. 10). While moles are not considered colonial in their habits, an individual will follow any runway that opens up to him, regardless of whether it or another mole has dug the passage. It is therefore sometimes possible to rid the entire premises of moles by trapping at one spot, and thus to avoid disfiguring lawns and garden beds in the operation.

It will pay to set traps on ridges over temporary hunting paths only when these have been constructed recently in damp soil, or have not become so dry that the mole would no longer find profit in using them in search of food. Since the ridges usually have many turns and windings, it is well to set the traps on a part of the path that takes a straight course for some distance or seems to be a connecting road between two sets of workings. The same plan should be followed with a line of mounds. Clusters of mounds are associated with numerous cross runs, thus lessening the chances of successful trapping.

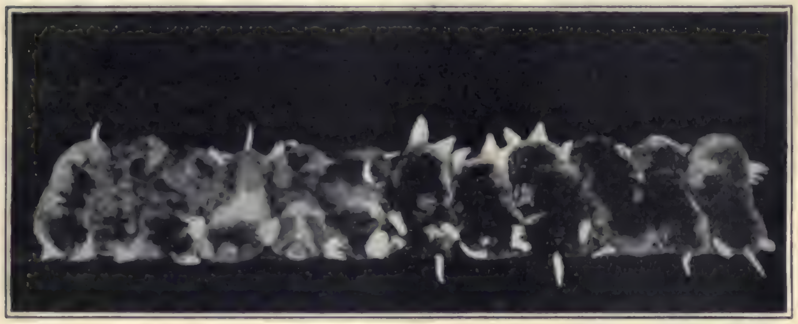

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Fig. 10.—One morning's catch of Townsend moles, near Puyallup, Wash. The broad hands and pointed snouts of these little fur bearers distinguish them from members of the rat and mouse tribe.

It is seldom worth while to set traps in a dry place. The mole generally works in a moist, rich soil, for there the digging is easy, and there its food abounds. Then, too, a satisfactory adjustment of the working parts of a trap can not be made in dry dirt. The more recent the signs of mole activity at any particular spot, the sooner a catch may be expected. It will pay to visit all traps twice a day, morning and evening. In the summer season they should be visited also in the middle of the day, for the hair on a mole pelt soon becomes loose in even moderately warm weather, and, as described farther on, the value of the pelts is such as to make trapping worth while.

WHEN TO TRAP.

Moles may be trapped successfully in the Pacific coast country at any season of the year, and elsewhere when weather conditions permit. In the Eastern States trapping will be more or less hindered in winter by snows and severe freezing. Moles are active all winter, however, and frequently have been caught along grass-grown fence rows and even in the deeper runways of open fields when the ground was frozen so hard as to necessitate the use of a pick in setting traps.

If trapping is undertaken chiefly with a view to gathering a harvest of fur, the best time of year for the operations is when the skins are prime. The fur of the mole is perhaps at its best in the winter season, but it is also classed as prime in midsummer, though it is somewhat shorter then. Less seasonal variation is found in the pelage condition of this burrowing mammal than in that of the fur-bearing animals that live mainly above ground. Nevertheless, during the molting periods in spring and in fall there is a deterioration in the value of the mole's fur (fig. 11). The spring pelage change is less marked than the fall and is more irregular in its occurrence, the time of molting varying with the individual, with sex, and with weather conditions. In a collection of more than 600 skins of the Townsend mole, taken in western Washington in all weeks of the year, the percentages of prime skins for the several months ran as shown in Table I.

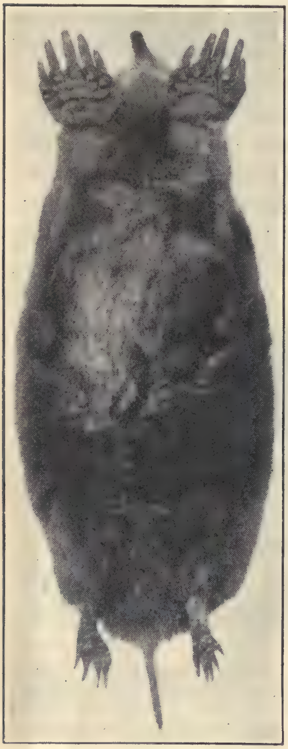

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FIG. 11.—Example of unprime pelt of the eastern mole, trapped near Fort Myer, Va., in the month of April. (The shape of the feet shown in the picture indicates the difference between moles and mice.)

TABLE I.—*Percentages of prime skins of moles taken in different months.*

Month.	Prime skins.	Month.	Prime skins.	Month.	Prime skins.
	Per cent.		*Per cent.*		*Per cent.*
January	100	May	80	September	65
February	75	June	90	October	10
March	75	July	80	November	15
April	50	August	95	December	95

The basis of classification in determining these percentages was the appearance of the leather side of the dried pelt—clear tan color for the prime skins and spotted or blotched with bluish black for those not prime. Moleskins are mainly thus graded by fur buyers, although, of course, the value depends also on the size of the pelt and the care with which it has been handled. Some skins are wholly bluish black underneath and all unprime skins are more or less thickened in the cutaneous tissue. Moleskins are considered marketable, no matter at what season of the year they are taken, but clear, prime pelts command the better prices.

KINDS OF TRAPS.

In Europe a great many moles are taken by means of homemade snaring devices. The trappers there also make use of both wooden and metal traps that are cheap and of simple construction, but none of those that have been tried out give satisfaction in this country. All types of mole traps in common use in America are made of metal and depend for their operation on the same sort of tripping device—a trigger pan designed to rest on an obstruction produced in the mole's runway when the trap is set.

FIG. 12.—A good strong garden trowel is the best tool to use in setting mole traps.

The trap is sprung when the mole follows its natural instinct to reopen the run by burrowing through or upheaving the obstruction. This may be confidently counted upon, for the mole has no more persistent habit than that of reopening and repairing its runways when they have been obstructed by accident or design. All efficient mole traps have been constructed with this habit in mind. The entire mechanism of such traps is above ground or concealed in the loose soil, no part being within the runway proper. It is useless to try to catch moles with any sort of device exposed in the runway, for the mole almost invariably burrows under anything placed in its path.

The catching and killing mechanisms of American mole traps are of three types: (1) choker loops, (2) gripping or scissor jaws, and (3) impaling spikes. Several different makes of the impaling or harpoon trap are on sale, particularly in the East and Middle West; in actual use, however, they are the least efficient of the three and have the additional disadvantage of injuring the skins of moles that are trapped for their fur. The other two types are illustrated in figures 13 and 14.

HOW TO SET TRAPS.

An excellent tool for use in setting mole traps is a good, strong garden trowel, such as is illustrated in figure 12. A spade or shovel may also be used, but one should take care to make the break or opening into the burrow no larger than is necessary to accommodate the trap; otherwise the mole may turn aside from the original course and pass through without being caught. Even when placing the trap on one of the shallow hunting paths it will pay, unless the soil is fairly loose and mellow, to dig into the runway and adapt the setting to known conditions, rather than to set from the surface by simply forcing the jaws or the loops into the soil. Sometimes, in digging, three or four forks of the burrow may be discovered, in which case there is nothing to do but fill the break and try elsewhere; a mole trap will face but two ways. No importance need be attached to the admonition one sometimes receives to use gloves in setting mole traps to prevent the animals' getting the scent of human hands; long experience has shown this precaution does not affect the catch in any way.

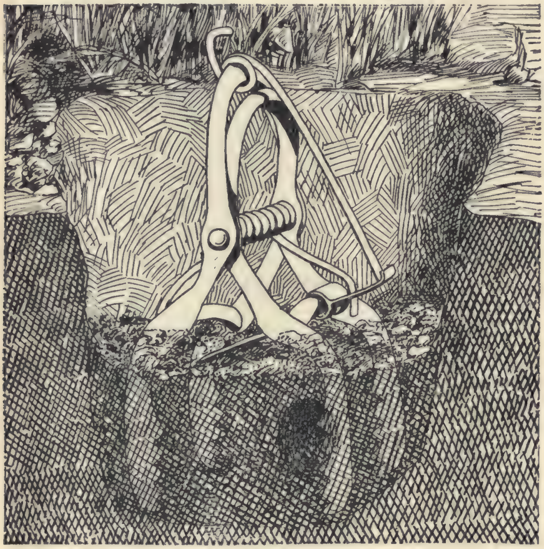

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FIG. 13.—Scissor-jaw, or gripping-jaw, trap. Phantom view, showing its position in relation to a deeper runway of the mole. The soil must be loosened with trowel and freed from obstructions, as sticks, stones, or clods, in order that the trap may act quickly. The jaws must straddle the course of the runway.

The location of one of the shallow hunting paths of the mole is plainly indicated by the surface ridge. To find a deeper runway from which a mound of earth has been pushed out, clear away the mound and feel or prod for the short passageway running obliquely down to the main tunnel. Follow its course, usually only a few inches, and place the trap on the main run.

Scissor-jaw traps.—To get the best results with the scissor-jaw type of mole trap (fig. 13) the soil in which the setting is made should first be loosened with a trowel and freed from sticks, clods, or pebbles, as the jaws must close through the soil to make the catch and will, of course, act the more quickly the less they are obstructed. In a deep setting make the excavation for the trap a little lower than the level of the bottom of the runway, for the tendency of a mole is to pass under rather than to one side of a break or obstruction encountered in its burrow. Then fill in enough loose damp earth to hide and block the passageway and settle the trap into place, its jaws straddling the course. This course may be determined by feeling for the tunnel openings with a small stick. The trigger pan should rest snugly on the soil, but the dirt should not be packed elsewhere under the trap, lest the mole upset or spring it before getting well within the jaws. Outside the base of the trap the soil may be pressed down, if need be, to hold things more firmly in place.

Choker-loop traps.—In setting the choker-loop trap (fig. 14) less attention need be given the matter of getting the soil fine and loose. The loops may be firmly forced into the ground with the certainty that they will react promptly when the trap is sprung. Traps of this type will also stand up to the work better than any of the others when used in heavy clay or gravelly soils. When placed in position on a mole runway the loops should encircle the course of the run and reach a little deeper than the level of the bottom of it. Before placing the trap on a deep setting fill in enough earth to come up against the frame. A convenient way of getting the trap into position is to hold the end of the trigger wire down with the left thumb, the fingers grasping the spring arm. Then with the free right hand compress the damp soil beneath the trigger pan, or place a little piece of sod under it, so that the two will be in snug contact when the setting is completed. As in the case of the scissor-jaw type, the soil should be loose under the trap except immediately beneath the trigger. This precaution applies particularly to the use of these traps for the large moles of western Washington and Oregon. Both traps were originally devised for the smaller moles east of the Rockies.

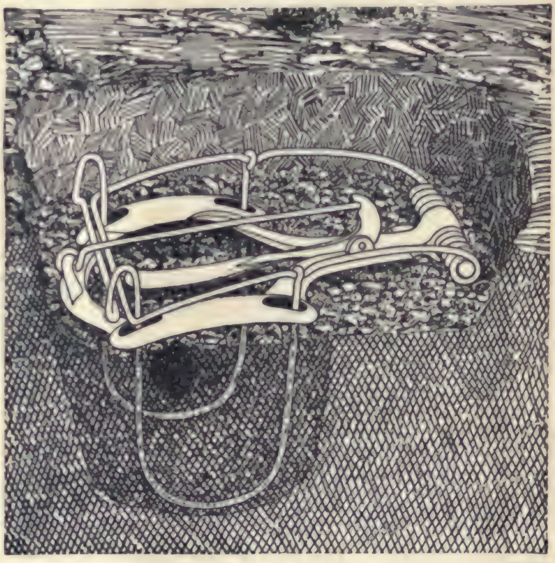

FIG. 14.—Choker-loop trap. Phantom view, showing trap placed in position on one of the deeper runways of a mole's system of burrows. The loops must encircle the runway.

UTILIZING MOLESKINS.

The solution of the problem of getting rid of the mole as a pest has been found in the value of the pelts to the fur trade. Until recently the little animal had been captured more with the aim of exterminating a nuisance than of utilizing its skin. In this way a by-product of trapping has long gone to waste, when an industry might have been developed that would have resulted in the production of beautiful and valuable garments or articles of apparel. It is significant of our lack of attention to small business matters that American moleskins were not sooner quoted or offered on the markets. Moleskin garments have been fashionable in this country, particularly in the large eastern cities, for many years, and fur dealers consider it probable that undressed mole pelts will continue indefinitely to have a marketable value, this value fluctuating, of course, with the demands of fashion and the visible supply.

In England, Scotland, and some of the Continental coast countries, moles are trapped extensively both for their pelts and for the private bounties paid for their extermination on certain estates. Up to about the year 1917, when the Biological Survey was prosecuting its investigations in the matter, the sole source of supply of moleskins for use by manufacturing furriers of this country was the pelts of the European mole,[7] obtained through importations from London. In periods when moleskin garments were in fashion, or when the skins were to be obtained at all, the volume of American business in furs of this class sometimes reached between $2,000,000 and $3,000,000 annually.

The Biological Survey has found that the skins of the common mole of the eastern United States are well within the class of the imported product, while pelts of certain other American moles are of much greater value for the furrier's purposes than those of the European species. They should, therefore, be classed by themselves. This applies particularly to the skins of the common large mole of western Washington and Oregon, which are larger and have better texture and fur than those of Europe. Since these facts have been recognized by a number of the more important fur dealers, a demand for American moleskins at prices remunerative to the trapper has developed. Figures obtained from the trade indicate that about $50,000 worth of American moleskins were marketed in 1918, and that in 1919 the business increased by nearly 25 per cent. This does not take into account the value of moleskins utilized in the home. Furthermore, values of the manufactured products—moleskin garments, fur sets, and fur trimmings—will approximate at least five times that of the raw peltry.

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[7] *Talpa europaea.*

SKINNING MOLES.

The process of skinning a mole is very simple, and with a little practice one should be able to do the job in five minutes, including the stretching of the pelt to dry. The skin envelopes the animal very loosely, showing considerable slack wherever handled. It is so tough, too, particularly in the larger species, that it will stand all the pulling necessary to remove it from any part of the body. Perhaps the best tool for the work is a small, strong pair of scissors about 4 or 5 inches long, with one blunt-pointed and one sharp-pointed blade (fig. 15). A pocket knife with a sharp-pointed blade may be substituted for the scissors.

Proceed as follows: With scissors or knife make a slit in the skin down the middle of the belly from chin to root of tail, loosening the pelt with the fingers as you proceed, to avoid cutting through into the abdominal cavity. Now husk the skin from the body, using the cutting tool only to sever the legs at the ankles, the tail at the root, and the arms at the wrists—all on the inside. After a little snipping at the connective tissue about the neck and head, the skin can be pulled over the nose and off the body entirely.

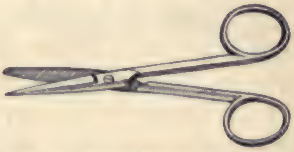

FIG. 15. — Scissors with one blunt and one sharp point, suitable for use in skinning moles. These should be strong, as the bones of arms and legs must be cut with them.

STRETCHING AND DRYING PELTS.

When the skin is off, pick from it any bits of fat that may have adhered and snip off the dangling legs and tail in such way as not to cut the pelt proper. Now stretch the skin on a board to dry, fur side down, using common pins for the purpose. They are strong enough, sharp, and do not leave holes in the pelt as tacks or nails would. A light tack-hammer will serve to drive the pins, and a pair of forceps with corrugated tips will help in the stretching, though after a little experience one will care to use the fingers only.

Hang the drying boards where the air circulates freely, but not in the sunshine. In damp or rainy weather it is best to dry the skins indoors, placing them as far as practicable from any stove or other source of heat. They will dry in a few days and, when stiff and parchmentlike, may be stored away indefinitely, though it is not best to hold them more than a few months to a year, as they become brittle with age when not tanned. They need no treatment with preservatives of any sort, but must be kept in a cool, dry place safe from insects and mice.

The European moleskins are stretched on drying boards in rectangular form, four pins only being used. Some fur dealers in this country also recommend the four-square shape. However, in this shape they do not dry so well at the edges, are more subject to insect infestation in the folds, and do not show to such good advantage when marketed as when they have been pinned out in the shape shown in the accompanying illustration (fig. 16). It seems worth while, also, to standardize the method of handling American moleskins in this way, so that they may be distinguished readily from the imported skins.

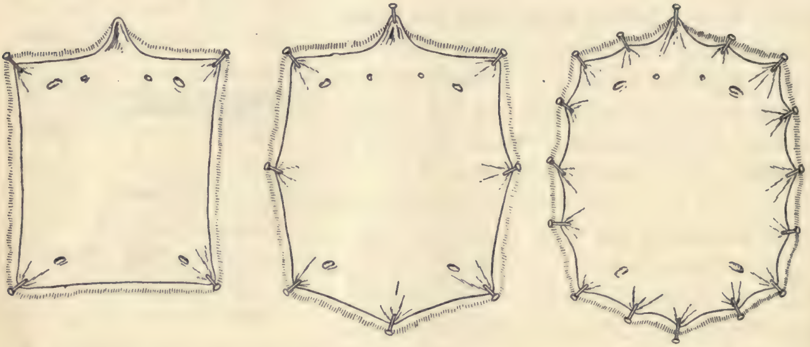

FIG. 16.—Drying skins on a board, showing the three stages of work on one skin: (1) Four pins are first used, one in each corner; (2) four intermediate pins are then inserted, the skin being slightly stretched; (3) finally, eight more pins are tacked in, one between each two of those already in place. A light tack-hammer will serve for driving the pins.

TANNING SKINS.

If it is desired to make up the skins at home for trimmings or fur pieces the following method of tanning will be found very satisfactory:

For a tanning liquor add to each gallon of water 1 quart of salt and one-half ounce of sulphuric acid. This mixture should not be kept in a metal container. Moleskins need not remain in the liquor more than one day, although no harm will be done if they are kept there longer.

When removed from this liquor the skins are washed several times in soapy water, wrung as dry as possible, and rubbed on the flesh side with a cake of hard soap. They are then folded in the middle over a line, hair side out, and left to dry. When both surfaces are barely dry and the interior is still moist they are laid over a smooth, rounded board and scraped on the flesh side with the edge of a worn, flat file or a similar blunt-edged tool. In this way an inner layer is removed and the skins become nearly white in color. They are then stretched, rubbed, and twisted until quite dry. Fresh butter or other animal fat worked into the skins while warm and then worked out again in dry hardwood sawdust, or extracted by a hasty bath in gasoline, increases their softness.

MAKING UP FURS AND TRIMMINGS.

In trimming or cutting the skins one should use a sharp knife or razor blade instead of scissors to avoid shearing the fur at the edges. When matching skins in a piece the best appearance is produced by arranging them so that the fur of no two adjacent skins strokes in the same direction. This produces a checkerboard effect that is pleasing.

The great bulk of the moleskins supplied to the manufacturing furriers in this country are dressed and dyed ("blended" or "tipped") by special processes involving the use of machinery. Most of this work is done in a few establishments in New York and Brooklyn. The leather side of the pelt is commonly dyed to prevent its light color from showing at the seams in a garment or where the fur may chance to part. This process, it is claimed, does not affect the color of the fur itself, which may be subjected to another bath in a dye to secure a uniform shade in all skins.

Not all the best grades of skins are dyed, and, when they all come from the same general locality, very pretty fur pieces may be made up at home or by a local furrier without any blending, provided one has skins enough from which to make a satisfactory selection. Fifteen to twenty skins of the common mole of the Northwest coast are sufficient to make an average-sized scarf for ladies' wear. Twenty skins will make a muff of average size and 30 skins a large one. About double these numbers of skins of eastern moles will be required for the same purposes. If muff foundations are not to be had locally they can usually be obtained through mail-order establishments.

Moleskin is imitated in the trade by shearing the fur of some animal having longer pelage, usually "cony" or other rabbit, cutting it into rectangular pieces, and dyeing it the proper taupe shade.

MARKETING MOLESKINS.

As a rule the farmer boy or the trapper who has accumulated a lot of moleskins will want to dispose of them as he would any other kind of pelt, by selling to a reliable fur dealer. Commonly the smaller local furriers do not handle this class of skin and are not posted on current prices or methods of grading. In this case it would be well to write for lists or quotations to one of the larger establishments doing business by mail. The plan of pooling shipments of moleskins through farm-bureau organizations has been successfully tried out in some communities. Inquiries in matters of this sort addressed to the Bureau of Biological Survey, Washington, D. C., will receive prompt attention.

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1922

FARMERS' BULLETIN 1248
UNITED STATES DEPARTMENT OF AGRICULTURE

The SUGAR-BEET NEMATODE *in the* WESTERN STATES

THE SUGAR-BEET NEMATODE is one of the most serious of the beet pests. It appears to have been imported with some shipments of beet seed many years ago. It has been found widely scattered in four of the western sugar-beet States and probably exists in other States where beets have been grown for several years.

The sugar-beet nematode is the cause of a great deal of loss to the beet grower through reduction of his tonnage, and of a corresponding amount of loss to the sugar producer through reduction of the output of sugar.

This bulletin treats of the nature and distribution of the sugar-beet nematode, indicates the most probable means by which this pest is spread, and suggests preventive measures and practical means of control.

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief
Washington, D. C. Issued February, 1922

THE SUGAR-BEET NEMATODE IN THE WESTERN STATES.

Gerald Thorne, *Assistant Nematologist*, and L. A. Giddings, *Agent, Office of Sugar-Plant Investigations.*

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HISTORY AND DISTRIBUTION OF THE SUGAR-BEET NEMATODE.

THE SUGAR-BEET NEMATODE[1] has infested many of the principal beet-growing regions of Europe, where it has become one of the most serious pests of the sugar beet and has caused severe losses.

It was first found in the sugar-beet fields of the western United States about 15 years ago. Since that time it has been found in many of the principal beet-growing sections of Utah, Idaho, California, and Colorado. Representatives of the Office of Sugar-Plant Investigations have made complete or partial surveys of all these regions except northern Colorado.

Surveys of nematode-infested areas in Utah were begun in 1919 and have been continued up to the present time. Franklin County, Idaho, was surveyed in 1918 and 1919. In 1920 the work was extended to include the Oxnard, Betteravia, Salinas, and Alvarado districts in California and the Arkansas Valley in Colorado.[2] The areas surveyed in four different States and the acreage found infested were as follows:

Utah, area surveyed, 24,473 acres, area infested, 3,238 acres; Idaho, area surveyed, 2,096 acres, area infested, 515 acres; Colorado, area surveyed, 7,160 acres, area infested, 899 acres; California, area surveyed, 18,945 acres, area infested, 2,535 acres; total area surveyed, 52,674 acres; total area infested, 7,187 acres. In reporting the infested acreage the total areas of infested fields were given. Since the actual infested areas vary from a few square rods to the entire field it will be conservative to figure the actual infested area as 25 per cent, or 1,797 acres. The average loss because of the infestation in these States may be estimated at not less than 6 tons of beets per acre, or 10,762 tons. Valued at $12 per ton, the prevailing price in 1920, the cash loss to the growers alone was $129,124.

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[1] *Heterodera schachtii* Schmidt.

[2] Acknowledgment is due to Dr. E. G. Titus, under whose direction this work was begun, and to Charles Price, George Q. Bateman, T. L. Smart, and E. W. Newman for their faithful work in the field.

The results of these surveys show that the infestation is spreading rapidly and in some localities has become a serious menace to the sugar-beet industry. The map shown as figure 1 gives the distribution of this nematode in the United States, as it is known at the present time. It should be noted that only about one-twentieth of the sugar-beet acreage in the United States has been inspected for the nematode, and it is probable that many additional infested fields will be found when a careful inspection of the other areas is made.

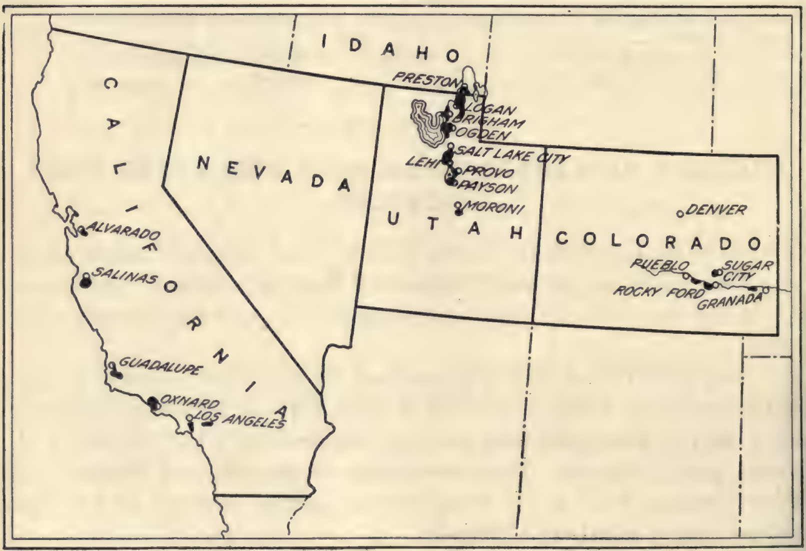

FIG. 1.—Outline map of four western beet-growing States, showing (by dark areas) where the sugar-beet nematode has been found.

LIFE HISTORY OF THE NEMATODE.

The forms of the sugar-beet nematode that are visible to the unaided eye are the females and brown cysts, which are about one-fourth the size of an ordinary pinhead. Practically speaking, these forms are masses of 200 to 600 nematode eggs. (Fig. 2.) These eggs are about one three-hundredth of an inch long and one-half as thick. (Fig. 3.) From them hatch very small, almost colorless, threadlike larvæ, which average one-sixtieth of an inch long. (Fig. 4.) They are equipped with a strong spear (fig. 5), with which they force an opening so that they can enter the roots of the beet, where they feed on the plant juices and molt.

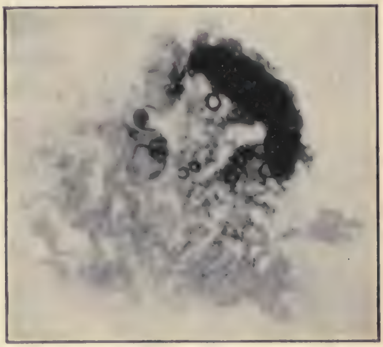

Fig. 2.—Cyst form of the sugar-beet nematode which has been crushed in order to show the eggs and larvæ. This cyst was taken from a field that had not been planted to beets for two years. × 20. Photographed by Gerald Thorne.

Up to the time of molting there is no visible difference between the sexes, but afterwards there is little similarity. The males remain similar to the larvæ except that they are somewhat larger and that their tails are blunt and their spears stronger. (Fig. 6.) After maturing they break their way from the roots and go in search of the females.

After molting the second time the females are flask shaped. As their size increases they break through the beet tissues and remain attached by their heads. Here they are fertilized by the males and soon develop into lemon-shaped bodies. A gelatinous semitransparent fluid is excreted, which collects in a mass about the posterior end, often filling the space between the female and the beet root. Into this mass eggs are deposited and there hatch, the larvæ finding their way into the soil or into the beet. The number of eggs deposited varies from a few to upward of a hundred from each female, and since several generations occur there are enormous numbers infesting the beet by the end of the season.

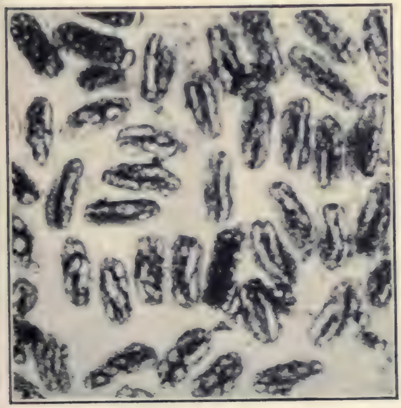

Fig. 3.—Eggs of the sugar-beet nematode from a brown cyst × 100. Photographed by Gerald Thorne.

As the season advances many of the females change in color from white to dark brown, becoming what is commonly known as the brown-cyst or preservation form. In this form the dead body of the female remains a protecting sack for the eggs with which she was filled, and in it they may lie dormant for many years. Just how long is not known. Each year, when favorable soil and moisture conditions occur, a few of these eggs hatch. The larvæ escape from the cyst either through the anal opening or through the opening left when the female broke loose from the beet root. (Fig. 7.) This leaves the cyst intact and a protecting cover to the eggs remaining within it.

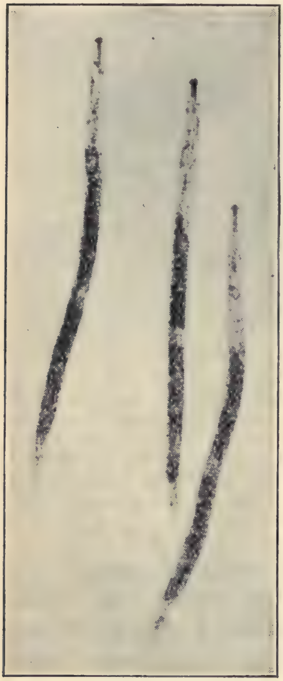

FIG. 4.—Larvæ of the sugar-beet nematode just hatched from the eggs. Note the sharp tails. × 150. Photographed by Gerald Thorne.

HOW THE LIFE HISTORY WAS STUDIED.

The life history and habits of the sugar-beet nematodes were studied in the laboratory to see if something might be learned that would suggest possible means of control. The depth at which they could be found in the soil, the depth at which they were found in the greatest abundance, the time when new cysts began to appear, and the possible succession of broods at more or less regular intervals were points kept constantly in mind.

For this work three fields were selected in 1919 and four in 1920. From these fields soil samples were taken at frequent intervals for examination. The soil in all these fields was a sandy loam, though there was a slight variation in the different fields, some having a deeper and looser soil than others. On the whole, the soil of these fields was typical of the region under investigation (Salt Lake County, Utah). From these fields 128 samples were taken and examined. From these samples 114,566 white females and 94,312 brown cysts were obtained. No attempt was made to obtain a count of the males and larvæ, owing to the fact that they are so small that they can be seen only with a microscope, and any method of separating them from the soil would be very slow and laborious. By determining the numbers of females and brown

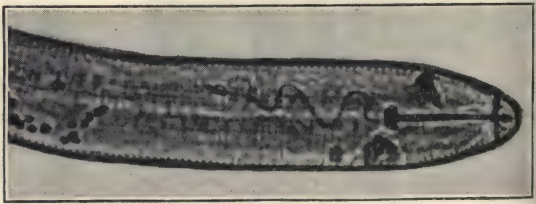

FIG. 5.—Head of the larva of the sugar-beet nematode, showing the spear with which it works its way into the beet root. × 1,000. Photographed by Gerald Thorne.

cysts a probable approximation of the comparative numbers of nematodes at various depths in the soil was obtained. These numbers no doubt represent only a small part of the males, larvæ, and undeveloped females that were actually in the beets and the soil surrounding them.

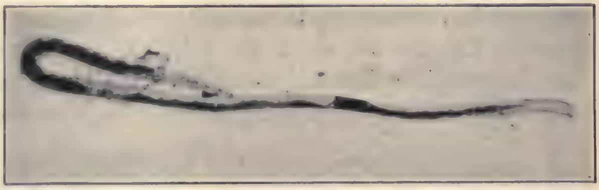

FIG. 6.—Adult male of the sugar-beet nematode. Compare with figure 4. Photographed by Gerald Thorne.

The samples were taken with soil tubes 6 inches in length and having an internal diameter of 2.84 inches, or a cross-sectional area of one-millionth of an acre. If the beet was small its top was removed, and the tube was placed over it and pressed down to its full length. Later in the season the tube was pressed down by the side of the beet, so as to include as much as possible of the root system on one side of the plant. It was then dug out, care being taken to cut the roots at the bottom of the tube, so as not to pull out any of the soil in lifting the tube. The second tube was then set in the place from which the first had been removed, pressed down, and removed in the same manner as the first tube. Five tubes, reaching to a depth of 30 inches, were successively used in taking many of the samples.

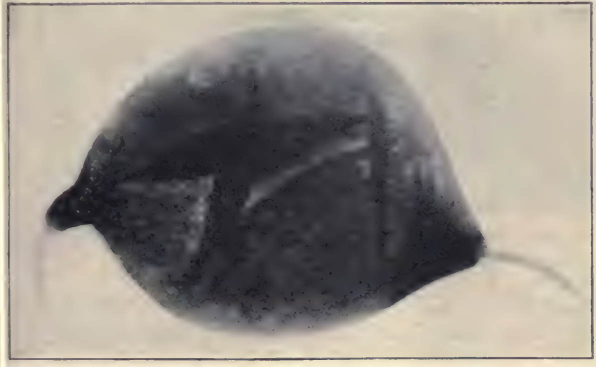

FIG. 7.—Larvæ of the sugar-beet nematode emerging from a brown cyst. The cyst remains intact and forms a protection to the eggs and larvæ yet remaining in it. × 100. Photographed by Gerald Thorne.

In examining these samples each 2 inches of soil was washed and examined by itself. The soil to be washed was placed in a pan filled with water and thoroughly worked with the hands to break up all clods. The whole was then stirred and poured off through a sieve having 40 meshes to the inch. More water was added to the material remaining in the pan, and the pouring process was continued until only the coarsest material was left in the pan. The finer material passed through the screen, and the nematodes lodged in the sieve together with the medium-sized material. This method of washing collected the females and the cysts but not the larvæ and the males. The material remaining on the screen was then examined and the nematodes counted.

After the samples had been examined and the counts made, tables were prepared showing the results obtained from each field for the entire season. One of these tables, that for field No. 2, examined in 1919, is here given, being typical of the results obtained from the seven fields under investigation. The table is arranged to show the total number of nematodes in each 2 inches of soil from the sample taken on the date shown at the left. At the right is the total number of nematodes for the entire sample, and at the bottom are the total numbers for all the samples for each 2 inches in depth.

Nematode counts, field No. 2, examined in 1919.

Date.	Depth in inches (number of nematodes found).															
	1 to 2	3 to 4	5 to 6	7 to 8	9 to 10	11 to 12	13 to 14	15 to 16	17 to 18	19 to 20	21 to 22	23 to 24	25 to 26	27 to 28	29 to 30	Total.
July:																
7	3	85	198	33	4	0	....	....	....	....	....	....	....	....	....	325
18	6	41	86	18	4	1	....	....	....	....	....	....	....	....	....	156
23	45	245	123	6	0	0	0	0	0	....	....	....	....	....	....	421
29	2	8	47	24	15	25	2	0	0	....	....	....	....	....	....	123
31	9	59	93	17	5	3	0	1	0	....	....	....	....	....	....	187
August:																
1	62	202	302	21	6	2	4	1	13	....	....	....	....	....	....	613
4	8	67	142	36	9	12	17	13	8	1	0	....	....	....	....	313
5	7	202	351	137	86	28	5	2	0	....	....	....	....	....	....	818
7	21	96	318	191	52	16	11	2	3	....	....	....	....	....	....	710
9	43	264	717	249	193	16	11	10	8	....	....	....	....	....	....	1,511
14	195	251	502	276	178	39	5	0	0	....	....	....	....	....	....	1,446
19	187	610	478	307	223	73	11	10	3	....	....	....	....	....	....	2,002
20	261	1,140	905	334	96	38	5	3	2	....	....	....	....	....	....	2,784
21	213	464	2,112	865	760	265	197	91	60	....	....	....	....	....	....	5,027
30	155	1,813	2,077	1,234	164	287	12	8	5	....	....	....	....	....	....	5,555
September:																
5	58	627	132	730	385	255	121	57	90	58	66	....	....	....	....	2,579
13	268	4,125	5,718	2,292	1,157	534	307	108	82	65	33	6	4	0	0	14,699
20	515	1,679	5,033	1,180	391	294	171	121	92	69	54	39	26	12	5	9,611
27	574	2,389	3,727	1,184	325	244	92	(a)	15	27	15	10	3	21	1	8,608
October:																
12	679	3,154	2,770	833	261	48	21	29	19	13	8	5	19	18	5	7,842
November:																
1	707	3,532	1,713	472	178	30	21	31	33	33	14	8	1	0	0	6,840
22	986	1,489	559	105	23	12	36	6	2	....	....	....	....	....	....	......
Total	5,004	22,542	28,103	10,644	4,517	1,952	1,116	493	435	226	190	68	53	32	11	75,426

[a] Sample lost.

The greater number of nematodes are found in the first few inches of soil, but what is of equal or even greater importance is the fact that they are found at a depth of 30 inches, and if samples had been taken at greater depths it is possible that infestation might have been found below 30 inches. The greatest number of nematodes for any 2 inches was found in the third 2 inches. The results obtained from the other fields correspond very closely with those given for field No. 2.

From a consideration of the results obtained from the seven fields from which samples were taken, it seems that control of nematodes attacking the sugar beet must depend chiefly on cultural methods and crop rotations. The data obtained did not indicate any definite succession of broods of the nematode. Much of the infestation seemed to come from cysts of former years which were found throughout the summer loose in the soil. The first cysts which were attached to the roots of the beet, and therefore were considered new cysts, were found on June 28. During the summer of 1920, soil samples were taken at different times between the rows of beets. In these samples great numbers of brown cysts were found, containing eggs and larvæ, but no females were found in the samples, probably owing to the absence of food plants necessary for their development.

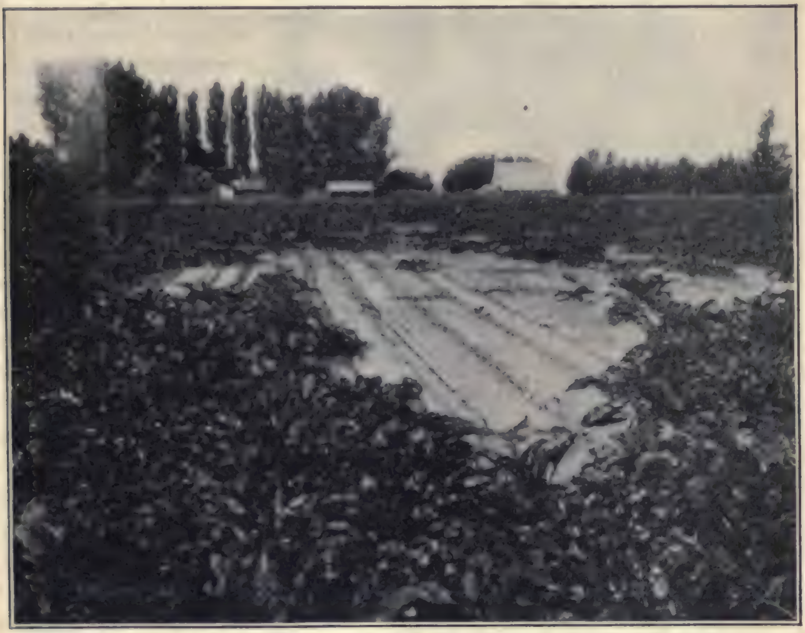

FIG. 8.—Sugar-beet field near Lewiston, Utah, containing a small area very severely infested with nematodes. Photographed by Gerald Thorne.

HOW TO DETERMINE NEMATODE INFESTATION.

The first symptom of nematode injury is the appearance of small areas in the field which produce no beets or only a few undersized ones. (Fig. 8.) Unless a considerable quantity of infested soil has been hauled into the field it is usually two or three years after infestation before the areas are large enough to attract attention. On severely infested areas the beets wilt and wither away just after thinning, often only a few remaining. These do not make as rapid growth as those outside the infested soil. If the infestation is only slight or moderate and the moisture and cultural conditions favorable for growth, the beets do not die but are smaller than those surrounding them. As the season advances these will be found to wilt down much more readily on warm days.

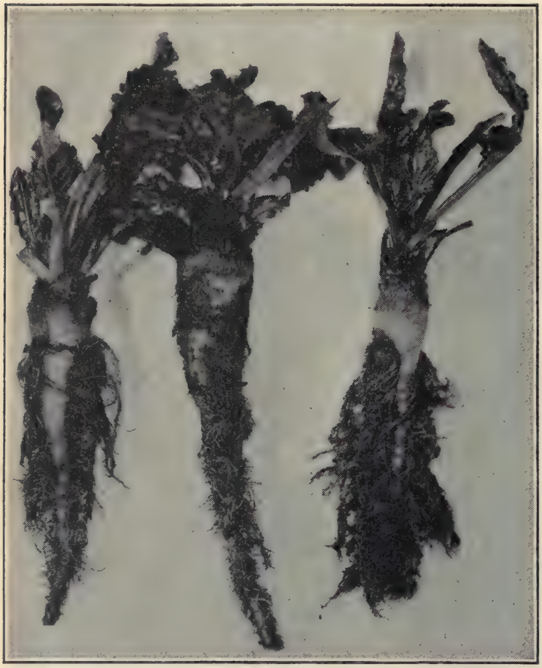

FIG. 9.—Beets from a field in which the crop was a complete failure because of severe nematode infestation. About one-third actual size. Photographed by Gerald Thorne.

If one of these infested beets be carefully dug up, it will be found small and stunted, with many more small roots than the normal beet. (Fig. 9.) In some instances the entire taproot is covered with these small roots, many of them being brown and dead. If nematodes are present, an examination will usually reveal small lemon-shaped white bodies clinging to the roots. These are the female form of the nematode. Later in the season these bodies are found on the beet itself, more than 100 to the square inch not being unusual. At this time it will probably be noticed that many of them are becoming brown in color. These visible forms of the nematode are not able to move at all, and the beginner should be careful not to confuse them with the sugar-beet aphis,[3] which is a true insect several times as large as the nematode and which can be seen to move slowly about. These aphids are commonly found in dry spots in the field where the beets resemble somewhat those infested with nematodes.

Other causes which produce an appearance similar to that of nematode injury are alkali spots in the soil, the garden or root-knot nematode, excessive moisture, and dry spots. In fact it is absolutely necessary to make a careful examination of the beet roots and to find the nematodes before their presence is known for a certainty.

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[3] *Pemphigus betae.*

Beets infested with nematodes appear to be more susceptible to leaf-spot, Phoma, and other leaf diseases, because of their weakened condition. For this reason diseases are sometimes assumed to be the cause of inferior growth when the actual primary cause is that of nematodes robbing the beet of its food. In the Arkansas Valley, Colo., the presence of small areas of leaf-spot in the fields was often found to be associated with nematodes, and because of the leaf-spot the infestation had been overlooked for several years.

At times it is very difficult to find the nematodes on the beets even in severely infested fields. This condition usually prevails in fields that are very dry, the nematodes having died from lack of moisture. The white females require considerable moisture and wither away to tiny white scales when dried. Careful examination of such fields will usually locate some of the brown cysts either attached to the roots or in the soil surrounding them.

One of the surest methods of determining whether the soil is infested is to put a few handfuls in a bucket of water and stir thoroughly. Many of the cysts, especially those from which part of the larvæ have emerged, will float on the top of the foam and collect around the side of the bucket. They resemble small brown seeds and will probably be mixed with some seeds that are slightly similar, from which they can be distinguished, however, by the fact that the seeds are larger and hard, while the cyst can be easily crushed. For one not accustomed to their appearance it may be difficult to be certain of them, and a small hand lens will be of service in identification. In case of doubt send a few pounds of soil to the office of Sugar Plant Investigations of the Bureau of Plant Industry, United States Department of Agriculture, Salt Lake City, Utah. It will be carefully examined, and if nematodes are present they will usually be found. This service is free of charge.

HOW THE SOIL BECOMES INFESTED.

The first nematodes probably reached the United States from Europe, being carried in sugar-beet seed. This is probable, because when beet seed is grown on land infested with sugar-beet nematodes, small clods of soil, which are often mixed with the seed, would be very likely to contain some of the brown cysts, and these would be planted with the seed. Since the infested areas are in many instances far apart, shipments containing infested soil must have been received in many localities.

After becoming established in a field the nematodes are spread over it in many ways. Cultural implements, especially cultivators, levelers, and harrows, drag particles of soil containing the nematodes from the infested area and scatter them in other parts of the field.

Irrigation water running over infested soil picks up the cysts and deposits them along the furrows, where new colonies are soon established. Live stock tramping over a wet field may carry cysts in the mud on their feet and thus distribute them to other parts of the field. It is doubtful whether the natural migration of the nematodes themselves will carry them more than a rod in a season, and therefore these other agencies are those which should be considered in preventing its spread. It is often found that the infested area in a field is only 3 or 4 rods wide and several times as long, following the course of irrigation and cultivation. (Fig. 10.)

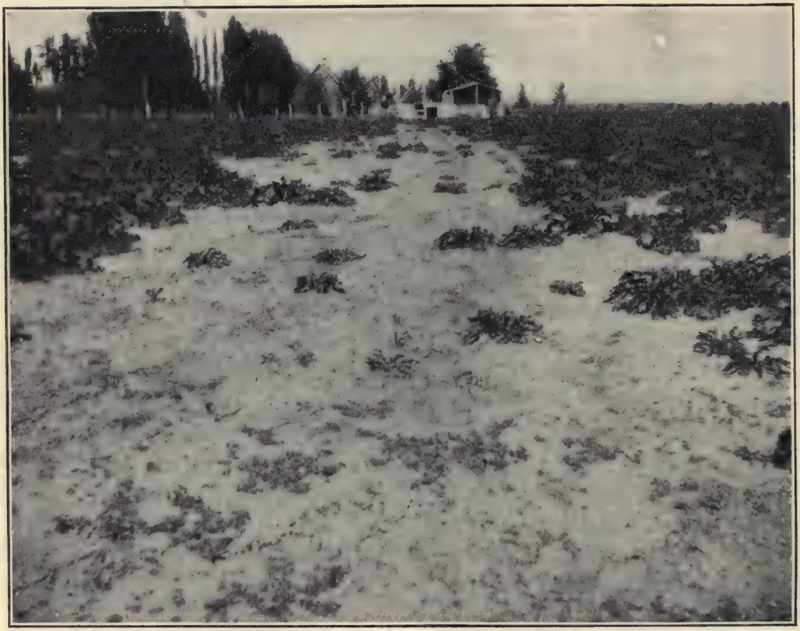

FIG. 10.—Sugar-beet field near Preston, Idaho, showing a nematode-infested area averaging 3 rods wide and more than 20 rods long, following the course of irrigation and cultivation. Photographed by Gerald Thorne.

From farm to farm the nematodes are carried by machinery, live stock, irrigation water, and any other methods that will transport the infested soil from one place to another. The common custom of farmers receiving back into their wagons the dirt from the beets which they have delivered at the unloading station, is probably the most serious method of distribution. Some of the soil from infested beets sticks to the dump screens, is jarred loose by the load of beets next following, and finds its way into the wagons of other farmers. In this way the farmers receive infested soil, take it to their fields and often scatter it, thinking that this good rich soil should not be lost. Fortunately this practice is becoming less common, and the dirt is disposed of before reaching home, but this is usually done along the road where wagon wheels and the feet of horses may pick it up and carry it into the fields.

CONTROL METHODS.

Dirt from the beet dumps apparently being the most common means of spreading the infestation, it should be the first to receive attention in planning control methods. Since the removal of dirt from the dumps seems to be the only practical method of disposing of the thousands of tons of soil annually screened from the beets, precautions must be taken to prevent scattering the soil containing nematodes. Wagon boxes should be tight enough to prevent soil jarring out along the roads and in the fields. Dump dirt should be disposed of in holes, swamps, or waste corners where there is the least danger of its being scattered.

The practice of growing beets year after year on the same field gives the nematodes an excellent opportunity to become established if they are introduced. A definite system of crop rotation should be adopted with not more than two years of beets in succession. The fertility of the soil will thus be maintained, and much of the danger from insect pests and plant diseases will be avoided at the same time.

When nematodes are found in a locality, action should immediately be taken to prevent their spread. This should be made a community affair, and the following measures are being adopted by some of the farm bureaus:

(1) The sugar company operating in the district is requested to refuse contracts for beets grown on soil that is known to be infested with the sugar-beet nematodes.

(2) When infested soil happens to be planted the owner and the sugar company are to make arrangements for handling the beets from the infested areas separately and not allow the infested beets to go through the dumps while other beets are being handled.

(3) The practice of throwing dump dirt along public highways is to be prohibited, by law if necessary.

After the extremely serious nature of the pest is realized there should be no difficulty in organizing such a cooperative campaign. The owner of infested soil should not desire to raise beets when the crop is likely to be a failure. The sugar company should not care to receive nematode-infested beets, which are low in sugar content, usually averaging about 10 to 12 per cent.

After the sugar-beet nematode has once become established in a field it is very doubtful whether it can ever be eradicated by employing methods that are applicable to field conditions. Experiments have demonstrated the fact that the nematodes live and reproduce in the soil to a depth of at least 2½ feet, and there are reports of their living deeper than this in warm climates. While protected by the cyst, the eggs are not injured by drying at the ordinary field temperatures. It is also impossible to drown them, since cysts submerged in water for several weeks contain all the eggs undamaged. Treating the infested areas with lime and other chemicals has been recommended, but considering the depth to which the nematodes live it is obviously out of the question to do this. While quicklime and some other chemicals kill all the nematodes with which they come in contact there are almost certain to be some which they can not reach.

Crop rotation and cultural methods must then be considered as the only practical methods of control that are available. The following information is based on the results of observations on several hundred infested fields under actual cultural conditions.

Moderately or slightly infested fields often can be made to produce good crops of beets by planting the seed at a time when it will sprout immediately and the small beets make rapid growth. In growing beets under these conditions it is necessary to have irrigation water available to apply whenever needed and thus keep the beets growing thriftily. Infested soil will require much more water than uninfested soil, for it is the moisture content of the beet carrying the plant food which the nematodes take. To supply this extra plant food the soil must be well fertilized and cultivated. Early planting is of advantage, provided irrigation water is available. If beets are allowed to want for water during the growing season there is very little likelihood of their recovering sufficiently from the nematode attacks to produce a profitable crop. Where rainfall must be depended upon it is very doubtful whether it would pay to attempt to produce beets on even slightly infested soil.

Severely infested fields will require a crop rotation to reduce the nematode population of the soil and also to put the soil in better condition. Since the brown-cyst form allows the nematode to lie dormant in the soil for several years, the rotation should cover not less than three years, and a longer period would be preferable. During this time a large number of the larvæ will have hatched and emerged from the cysts, and these will die if no suitable food plants are available.

The subject of food plants is an important one in planning the rotation. Fortunately, all the common crops, including wheat, oats, corn, barley, potatoes, peas, beans, alfalfa, and the clovers, are not injured by the sugar-beet nematode. In certain localities some varieties of these crops may be host plants, but observations made on many severely infested fields have never shown the sugar-beet nematode on any in the above list. In fact, it is very common for these crops to make a larger growth on the severely infested areas. This is explained by the fact that these areas have produced no crop while planted to beets and yet have received cultivation and care equivalent to a good summer fallow. The only cultivated crops found by the writers to be injured are cabbage, cauliflower, turnips, table beets, and mangels. However, the sugar-beet nematode is known to thrive on certain weeds, among them being mustard, pigweed (lamb's-quarters), and saltweed. A few are sometimes found on knotweed, redroot, and purslane. Clean seed and clean culture will therefore be essential if any good results are to be gained in making the rotation.

The shortest crop rotation that has given a good crop of beets on severely infested soil is one or two years of either peas or beans. By keeping the beets growing thriftily it is possible to harvest a good crop after this short rotation, but no attempt should be made to grow a second crop, as it almost invariably fails.

Another apparently successful rotation is as follows: Wheat or oats as a nurse crop for alfalfa. The following spring allow the alfalfa to grow about 1 foot high; then plow under and plant potatoes. The next year grow beets, and then repeat the rotation.

A rotation of three or four years of grain, potatoes, or other nonleguminous crops seldom gives a good crop of beets and should not be depended upon if a legume crop can possibly be grown.

Complete eradication of the sugar-beet nematode by a long crop rotation may be possible, but the following records of nematode-infested fields show that it is a very difficult thing to do:

(1) Alfalfa nine years. Soil still contains thousands of cysts and many of them have many eggs remaining in them in which the larvæ are alive and active.

(2) Wheat as a nurse crop for alfalfa, alfalfa four years, potatoes two years, beets (26 tons per acre), beets (11 tons) very severely infested with nematodes.

(3) Wheat as a nurse crop for alfalfa, alfalfa five years, wheat, beets (12 tons, allowed to get dry in July and never recovered), beets (11 tons) very severely infested again.

(4) Wheat, barley, alfalfa five years, wheat, wheat, beets (18½ tons, but so severely infested that the owner will not risk another crop).

(5) Mixed-grass pasture five years, wheat, wheat, beets (16½ tons), beets (9 tons very severely infested).

All of the fields mentioned above were under good farming practice, and the number of weeds growing in any one of them was probably no greater than would be found in any field in which an effort was being made to keep it clean. It will be noted that even these long crop rotations gave only one good crop of beets. Therefore the shorter rotations seem to be about equal so far as the beet crop is concerned, but the longer rotations should be used if possible, as the continual production of crops of only one or two kinds will in time deplete the soil of some of its important elements.

Remember that the nematode is a worm and must be carried into a field in order to get there. Beets may be grown in a field indefinitely, and no nematode will appear if it is not carried there. As mentioned before, there may be a slight possibility of its being carried in beet seed, but the most common means of distribution from field to field is through the dump dirt and the exchange of machinery which has been used on infested land. If such machinery is carefully cleaned after being used there is little probability that nematodes will be carried in this manner. By taking the precautions heretofore mentioned there is little danger of getting the soil infested with the sugar-beet nematode. And since it injures practically none of the other common crops there is no reason for hesitating to grow beets.

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FARMERS' BULLETIN 1249
UNITED STATES DEPARTMENT OF AGRICULTURE

OLIVE GROWING

IN THE SOUTHWESTERN UNITED STATES

THE INTRODUCTION of olives into southern California took place 150 years ago, when the Franciscan Fathers made the first plantings near the San Diego Mission. Since then olive growing has become widely disseminated in many parts of California, in Arizona, and to a very limited extent in a few other sections, although it is only within the past 30 or 35 years that the olive industry has assumed a place of importance in the commercial fruit industry of the United States.

The olive can be grown successfully only in a comparatively mild climate. A temperature of 10° to 14° F. above zero is likely to prove disastrous to the tree, and the fruit will usually be injured by a drop below 28° F. Furthermore, there are other limitations. Although the tree thrives fairly well in the humid regions of the South, where the temperature conditions are favorable, fruit production there is not sufficiently dependable to justify the planting of trees. The dry atmospheric conditions of California and the arid Southwest, where the temperature range is favorable and where irrigation supplies the necessary soil moisture, appear to meet the requirements of the olive.

Though few fruit trees withstand the limited soil moisture that the olive can endure, it likewise responds, as do other trees, to favorable soil conditions; in fact, it is only under such conditions that regularly successful results can be expected.

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief

Washington, D. C. February, 1922

OLIVE GROWING IN THE SOUTHWESTERN UNITED STATES.

C. F. KINMAN, *Pomologist, Horticultural and Pomological Investigations.*

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OLIVE GROWING IN THE UNITED STATES.

NEARLY a century and a half ago the Franciscan Fathers brought to this country some olives and planted them at the San Diego Mission, situated near the site of the present city of San Diego, Calif. This first planting, whether in the form f cuttings, seeds, or otherwise, was the source of what is now known s the Mission variety. From here, during the next few years, the

IG. 1.—Trees of the original planting of Mission olives at the San Diego Mission near San Diego, Calif. (Photographed in May, 1920.)

trees were distributed to a number of missions in southern and central California. Some of the original trees, also those planted at the other missions, are still thrifty and productive (figs. 1 and 2). The olive was for many years the most prominent fruit in California; in fact, aside from the grape and the fig, which were introduced by the Mission Fathers about the same time as the olive and to each of which has been given the name "Mission," there were no other fruits of importance in California. On account of the sparse population, only small plantings of olives were made, and the culture of these was often neglected until nearly a century later, when interest in olive growing received a new impetus and a few men planted good-sized orchards. From that time plantings have continued to increase, until today olive culture is a prominent factor in fruit production in California and is of some importance in Arizona. Statistics show that 503 olive trees were growing in California in 1855;[1] in 1876[2] there were 5,603 trees of bearing age; in 1901 the number was 539,568; and in 1919[3] there was a total of 37,412 acres of olives in California, with 24,285 acres in bear-

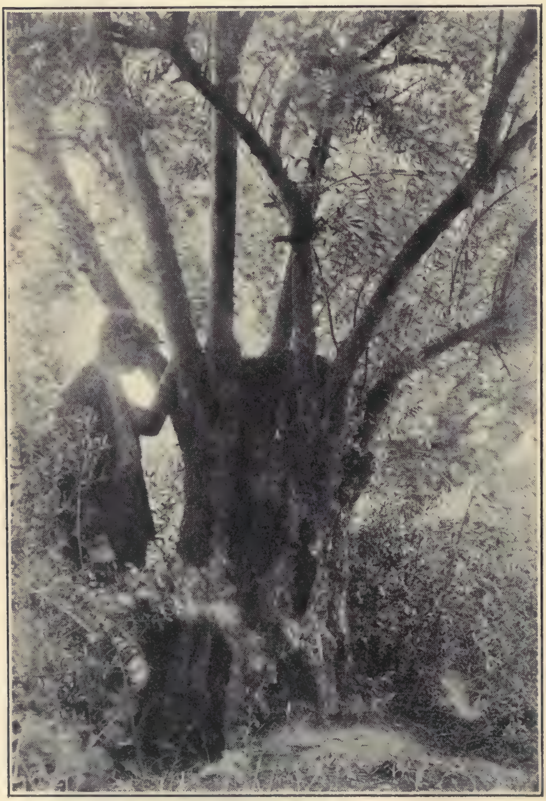

FIG. 2.—A tree of the original olive planting at the San Fernando Mission, Calif. The tree as here shown was cut back several years ago to render the harvesting less expensive. The present top consists of sprouts from the stump. (Photographed in May, 1920.)

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[1] Thomas, Daniel J. On agricultural statistics of the State. *In* Trans. Calif. State Agr. Soc., 1859, p. 343. 1860.

[2] Table of statistics . . . 1876, as reported to the surveyor general by the several county assessors, embracing the entire State. *In* Trans. Calif. State Agr. Soc., 1876, p. 125. 1877.

[3] California Olive Association survey.

ing. In 1917 there were 608 acres in olives in Arizona. The production of olives in California[4] in 1918 was 13,801 tons. No accurate data on the production in Arizona exists, but the yield for 1918 has been estimated at approximately 100 tons.

The importation of olives from foreign countries in 1919 amounted to more than 3,950,000 gallons; also about 8,300,000 gallons of edible oil and 287,000 gallons for mechanical or manufacturing purposes. Until 1900 almost the entire production of olives in this country was utilized for oil, although for a number of years small quantities of green-olive pickles were made, and during a few years previous to this considerable interest was given to experiments in the processing of ripe-olive pickles, the article which is now the basis of the olive-growing industry in this country.

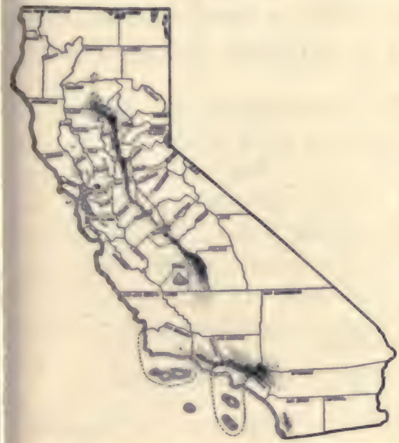

FIG. 3.—Outline map of California, showing by means of dots the principal sections where olives are grown.

As there is great interest in olive planting and a vast area of land suitable for olive culture is lying within regions of congenial temperatures in California and Arizona, there are prospects for a continued growth of this industry, the profitable marketing of the crop perhaps being the primary limiting factor.

Natural conditions have never given the olive industry any serious setback, but serious handicap has been experienced through the adulteration of the oil or the sale of other oil as olive oil, when the making of the latter was gaining rapidly in importance during the last years of the past century, and also through the faulty sterilization of ripe pickles, which recently resulted in reducing temporarily the consumption of this commodity.

CULTURAL DISTRIBUTION.

The region in which the olive may be successfully grown for the commercial production of fruit in the United States is not as great as for most frost-hardy fruits and has been confined to portions of California and Arizona, although the trees will live and bear some fruit in portions of all of the southern tier of States of this country.

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[4] Hecke, G. H. California crop distribution and estimates, 1918 . . . *In* Calif. State Com. Hort. Mo. Bul., v. 8, no. 4, p. 164. 1919. In cooperation with U. S. Dept. Agr., Bur. Crop Estimates.

Figures 3 and 4 show the regions in California and Arizona where olive growing is now a commercial industry. As with all other fruit crops in the comparatively warm, dry regions of the southwestern United States, the development of the olive industry has been, to a large degree, centered in a number of rather widely separated but extensive sections. Olives are found scattered throughout all the warm valleys where rainfall or irrigation is sufficient for the needs of the crop and where the range of temperature is favorable.

The olive is now grown commercially in at least 36 of the 58 counties of California and in a few counties of Arizona. The industry extends from near the border of Mexico to and including Shasta County, which lies next to the most northern county of California. This northern limit reaches nearly to the forty-first degree of north latitude.

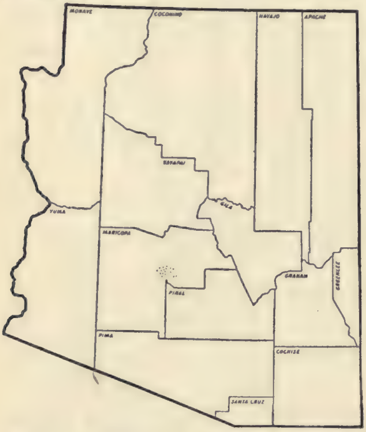

FIG. 4.—Outline map of Arizona, showing by means of dots in the general vicinity of Phoenix the location of the principal olive-growing section in that State.

For convenience, the region of commercial olive production is here divided into five natural sections: (1) The Sacramento Valley, (2) the San Joaquin Valley, (3) the central California coast (the San Francisco Bay) section, (4) southern California, and (5) southwestern Arizona.

THE SACRAMENTO VALLEY.

The olive is grown to a considerable extent through the central portion of the Sacramento Valley and the rolling foothill district to the east and north, with centers of most importance near Oroville, in Butte County; at Fairoaks, which lies northeast of the city of Sacramento, in Sacramento County; and at Corning, in Tehema County. More than 14,000 acres of olives are growing in the entire valley, of which over 8,000 acres are of bearing age. Little attention is given this crop in the southwestern portion of the valley, which is swept by cold, moist winds throughout most of the summer.

THE SAN JOAQUIN VALLEY.

The San Joaquin Valley joins the Sacramento Valley and lies to the south of it. Although the most extensive olive plantings have been made in the southeastern portion, olive trees may be found scattered throughout the valley (fig. 5). There are nearly 11,000 acres of olive orchards in this section, of which 5,500 acres are in bearing. Nearly half of both bearing and young trees are in Tulare County, Lindsay and Exeter being the principal centers. Plantings in each of three counties, Madera, Kern, and Fresno, cover more than 1,000 acres, of which little over one-half are in bearing. The nonbearing acreage (trees not of bearing age) in this and in the Sacramento Valley, indicates the keen interest taken in this crop during the past few years. The deep, heavy, fertile soils of several types—sandy loams and gravelly, dry adobe—which characterize the southeastern portion of the valley where olives are planted are conducive to a more vigorous tree growth than are the conditions in localities farther north in this valley or in most places in the Sacramento Valley.

Olive acreage in California in 1919[1] *and in Arizona in 1917, by counties.*

CALIFORNIA.

Section and counties.	Bearing.	Nonbearing.	Total.
Sacramento Valley:	*Acres.*	*Acres.*	*Acres.*
Butte	3,229	1,981	5,210
Tehama	2,006	1,034	3,040
Sacramento	1,026	971	1,997
Shasta	519	593	1,112
Yuba	586	533	1,119
Glenn	355	590	945
Placer	343	70	413
Other counties	196	125	321
Total	8,260	5,897	14,157
San Joaquin Valley:			
Tulare	2,567	2,729	5,269
Madera	558	575	1,133
Kern	444	721	1,165
Fresno	629	469	1,098
San Joaquin	538	287	825
Merced	301	159	460
Stanislaus	202	203	405
Kings	100	210	310
Mariposa	235	....	235
Total	5,574	5,353	10,927
Central California coast (San Francisco Bay):	*Acres.*	*Acres.*	*Acres.*
Sonoma	650	....	650
Santa Clara[2]	230	....	230
Napa	202	....	202
Other counties	212	15	227
Total	1,294	15	1,309
Southern California:			
Los Angeles	2,717	330	3,047
Riverside	1,822	638	2,460
San Diego	1,521	245	1,766
San Bernardino	901	502	1,403
Ventura	1,234	....	1,234
Santa Barbara	492	63	555
Orange	362	....	362
Imperial	108	84	192
Total	9,157	1,862	11,019
Total for State	24,285	13,128	37,412

ARIZONA.

Counties.	Acres.
Yavapai	12
Maricopa	499
Pinal	61
Santa Cruz	31
Cochise	5
Total for State	608

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[1] California Olive Association survey.

[2] Calif. State Com. Hort. Mo. Bul., vol. 8, No. 4, p. 164.

THE CENTRAL CALIFORNIA COAST (SAN FRANCISCO BAY) SECTION.

Soon after olive culture had become a factor in fruit growing in California, that portion of the State which includes the counties lying adjacent to or near San Francisco Bay was looked upon as offering promising conditions for its culture, but owing to the cool, moist sea breezes which prevail during the summer months over most of the section the returns have not warranted continued planting. Aside from the fruit not reaching a satisfactory size, the ravages of the black scale are general and severe. In some instances olive trees in this section have been removed to make way for the planting of more profitable crops. In places not swept by the cool winds and where climatic conditions are more like those of the interior valleys, the olive gives satisfactory returns. In 1919 a little more than 1,300 acres of olives were growing in this locality, and almost the entire area was in bearing.

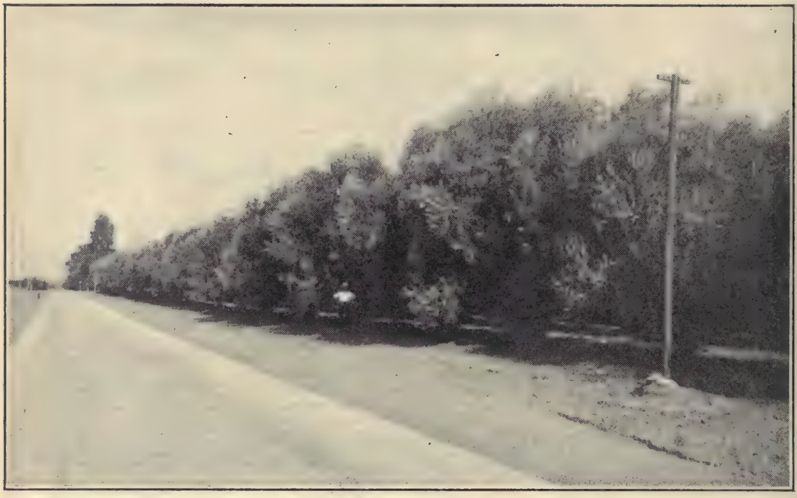

FIG. 5.—An orchard of olives of the Mission variety in the San Joaquin Valley, Calif. (Photographed in August, 1920.)

SOUTHERN CALIFORNIA.

During the early years of the olive industry it was in the section comprising the southern third of California, from Santa Barbara County southward, that most of the olive trees were planted. The acreage in this fruit has continued to increase, although not as rapidly during very recent years as in the interior valleys farther north. In 1919 more than 9,166 acres were in bearing, which is a greater area than in any of the other sections mentioned, and the total planting was 11,019 acres, which is about the same as in the San Joaquin Valley and considerably less than in the Sacramento Valley. The counties in this section in which olive culture has reached greatest importance are Los Angeles, Riverside, Ventura, and San Bernardino, although orchards are found in all the warm valleys where irrigation water is available. Plantings have recently been made in the Imperial Valley, where considerable interest has been aroused in this fruit. As in the northern valleys, plantings are for the most part confined to the slightly elevated places through the valleys and on approaches to and over the low rolling foothills where irrigation water is available and where frost injury to the fruit is least common.

ARIZONA.

Olives are grown commercially in a few counties of Arizona. The only important center of the industry (and, therefore, the only one considered here) is located near the city of Phoenix. In this section the scattered orchards total about 500 acres. Plantings in the remainder of the State aggregate about 100 acres. Most of the orchards in this locality were planted near the beginning of the present century, although some were set out a number of years earlier. The earlier plantings were for the most part for the purpose of oil production. During the past few years olive planting has stopped almost entirely, as the interest in fruits has been diverted to farm crops, of which cotton is the most important.

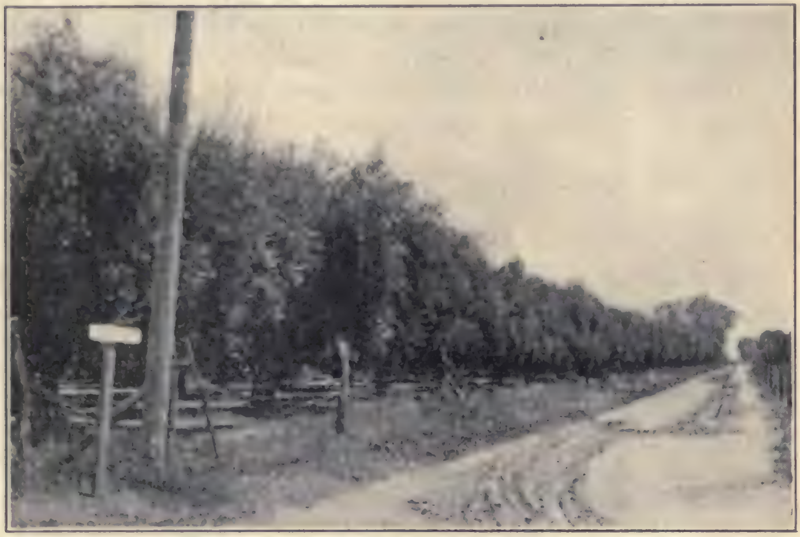

FIG. 6.—An orchard of olives of the Manzanillo variety near Phoenix, Ariz. (Photographed April 27, 1920.)

Both tree growth and fruit production in parts of this district where water for irrigation is available indicate that the soil is fertile and that natural conditions are satisfactory for olive culture (fig. 6). Climatic conditions here are similar to those of the principal olive-growing districts of the interior valleys of California, except that the summers are somewhat hotter and the annual rainfall less.

In these sections, as in other olive-growing districts, there is danger of injury to the fruit by early freezes if the crop is excessive and therefore late in ripening or if the varieties planted are naturally late in maturing. The Mission and Manzanillo varieties are the principal ones grown for pickling, while a few old orchards are still maintained for oil production.

CHOOSING A LOCALITY AND SITE FOR OLIVE PLANTING.

In selecting a locality for establishing an olive orchard, the questions of most importance to be considered are for the most part the same as for other fruits. They include climatic conditions, the moisture requirements of the trees, soils, good roads, and the distance between the market or processing plant and the immediate orchard site.

LOCALITY FACTORS.

CLIMATIC CONDITIONS.

The most satisfactory climatic conditions for the olive are mild winters, where killing frost does not occur until late in the fall, and hot dry summers. A temperature below 28° F. above zero will usually injure the fruit and 10° above zero will prove detrimental to the trees. Cold, moist, or hot dry winds are not conducive to the setting or maturing of the fruit. Cold dry winds are especially damaging to the partially ripened fruit, causing it to shrivel. Such fruit can be used for oil only and is of second grade even for this purpose. If warm weather follows and there is sufficient moisture in the soil, the fruit will usually regain its natural plumpness. The olive does not blossom until after the danger of spring frosts is over, but it ripens its fruit very late in the fall when in most localities in the olive-growing regions of California and Arizona there is danger of injury to the fruit by light freezes.

MOISTURE REQUIREMENTS.

As it thrives best in a hot dry climate and the trees will live where protracted droughts are frequent, it was believed for some time after the olive was introduced into cultivation in the United States that irrigation was not necessary even where the close planting of the trees was practiced and where no intensive dry-farming systems were employed. This belief resulted in unprofitable returns from many orchards. At the present time it is recognized that, for satisfactory production, the olive is as dependent as are other fruits upon an adequate water supply. Owing to its requirements of a hot dry region where the black scale is not destructive and of an elevated site on rolling or sloping land for assurance against frost, irrigation is almost imperative for the regular production of abundant crops of large fruit. Dry rolling land where irrigation is necessary and water for it is available is therefore favorable, if not requisite, to the profitable production of olives for ripe pickles. For these reasons olives are not being planted to any extent for commercial orchards in localities where irrigation water is not available or where rains are not sufficient to provide for a good tree growth; for even with a good setting of fruit in such sections the crop is likely to prove unprofitable because of insect pests and because of the effect of other attending conditions which are adverse. Probably 85 per cent of the olive orchards of California and almost the entire olive acreage of Arizona are under irrigation.

SOILS.

Olives are found growing on many types of soil, but they prefer those which are well drained and fertile. Loams, sandy or gravelly loams or clay loams, which have not too high a percentage of humus or nitrogen are most satisfactory, although adobe land, if watered and given good surface cultivation to prevent the drying out and cracking of the surface, has given good results. The belief that the olive would make a good growth and produce profitable crops where nothing could be expected of other fruits has caused many failures, and at present only soils which are considered suitable for other fruit crops are used.

Olive plantings for the most part have been made on reddish, brownish, or grayish sandy or gravelly loams belonging to the residual or old valley-filling material groups, which are friable and well drained and darkened by a desirable quantity of humus. Although these types have proved to be satisfactory, their selection by olive planters resulted as much, probably, from a choice of climatic conditions as of soil, as they are the types on the lower rolling foothills, where the air drainage is good and detrimental frosts are not common during the ripening season.

Profitable orchards are found also scattered through the broad valley bottoms on fertile, well-drained, friable soil areas where sites of slight elevation are found, although the predominating soil type of these regions is characterized by a layer of heavy red-clay subsoil and of hardpan which prevents the penetration of tree roots and water.

Trees should not be planted where there is near the surface a stratum of hardpan or other material which is impervious to water.

In such places the tree grows very slowly and produces small crops, if any, and sometimes is affected with die-back or exanthema. Where trees have been planted in such soil, breaking up the subsoil by blasting if the stratum is beyond the reach of the subsoil plow, so that water may penetrate it readily, is considered advisable.

Where the stratum of heavy subsoil or hardpan is a few feet below the surface olive trees seem to do well if good culture is given, as they are naturally shallow rooted and do not require the depth of soil demanded by some trees.

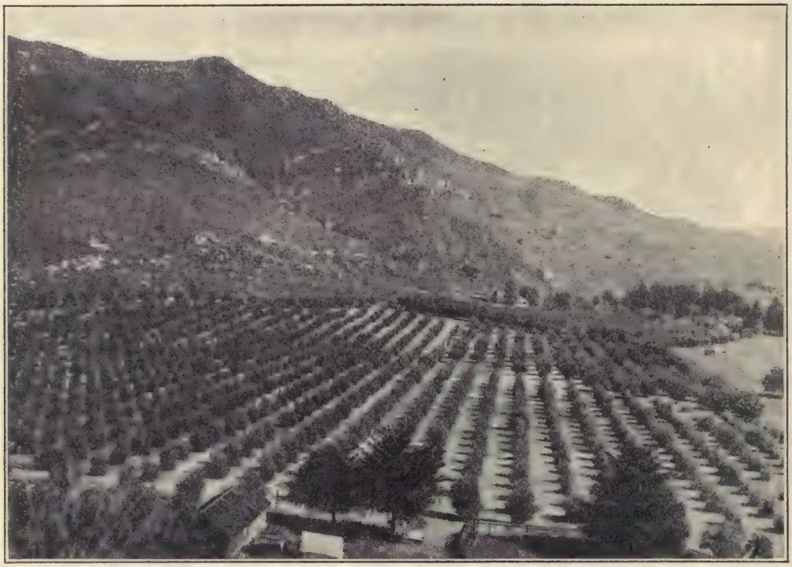

FIG. 7.—An olive orchard near El Cajon, Calif. (Photographed in 1918.)

Soils very rich in humus and nitrogen are inclined to result in excessive wood growth, in only moderate crops, and in delayed ripening of the fruit. This necessitates considerable pruning and expensive harvesting and involves occasional severe losses by the freezing of the fruit before it is ripe enough to harvest. Olive trees will live in soils where the humus and nitrogen content is very low, although in such places they usually make but little growth and bear unprofitable crops.

SITE FACTORS.

Points of the most importance in the selection of an olive orchard site are (1) air currents, (2) soil drainage, (3) a contour suitable for irrigation, and (4), as with all other commercial fruits, areas where cultivation, harvesting, and marketing may be economically accomplished. As the fruit will be injured by freezing and will not ripen after it is harvested, the selection of a site free from low temperatures during the fall and early winter is of first importance. Low flat lands, the lower portions of ravines, and high flat tablelands should therefore be avoided; sloping stretches and rolling areas with the exception of the lower portions should be chosen, the elevation above sea level being of far less importance than the elevation above the valley or depression immediately adjoining (fig. 7). The air drainage in a depression of but a few feet below a frost-free area may be so poor that temperatures sufficiently low to render fruit unsuitable for pickling will occur. The same is true of the lower portions of ravines through which the heavy cold air flows to lower levels. Surface water drainage is usually satisfactory where the slope is sufficient to insure air drainage, but care must be taken to avoid places where the subsoils are retentive of water. Places exposed to prevailing strong or dry winds should be avoided, on account of the danger of damage to the blossoms, the very young fruit, or the fruit nearing maturity. On the other hand, moderate night breezes are desirable during the ripening season, on account of their tendency to prevent damaging frosts.

VARIETIES.

The Mission variety, which is the one generally accepted as the best for planting in sections of the United States where olive growing is an industry and of late years has been most extensively planted, was also the first to be introduced. As it was for many years the only variety available, it was planted in most of our present olive-growing regions. During the last 30 or 40 years of the nineteenth century 80 or more varieties were introduced, mainly from Spain, Italy, and France, and grown in California. Most of this work was done in the southern portion of the State. Practically all of these varieties were imported for the purpose of manufacturing oil. When the oil industry was displaced by the more profitable pickling of the large ripe olives, the demand for most of the small-fruited sorts which had been grown for their oil disappeared. As in the importation of varieties of other fruits, a large percentage of the varieties of olives proved to be unsuitable for commercial planting in this country, and most of them have been discarded. A few of these varieties, on account of ripening their fruit early in the fall or owing to their extra large size, are still being planted by those who are partial to these qualities. Only a few orchards of the oil-bearing olives remain, the others having been removed or grafted to large-fruited varieties.

The most important varieties at present, aside from the Mission, are the Manzanillo, Ascolano, and Sevillano. Plantings of a few others, including Nevadillo (*Nevadillo Blanco*), Redding (*Redding*

Picholine), Columella, Rubra, Uvaria, Pendulina, and Oblonga, may still be found, but nurserymen claim that there is little demand for trees of these sorts for planting. The few really important varieties have been grown for a number of years under a wide range of conditions, and their performance in a locality has established their comparative merits and the advisability of their continued planting in that section.

MISSION.

The Mission variety was disseminated from the Mission plantings in California, where it was grown from importations from Mexico and is now the most important variety. It is grown in all important olive-growing sections. Its popularity results from the satisfactory growth of the tree and the production and high quality of its fruit for both ripe pickles and oil. The fruit is medium to large in size, although varying considerably in this respect, depending upon the size of the crop and the cultural conditions. The fruit is usually large if the crop is light or the cultural conditions good and is smaller when the crop is excessive or when unfavorable growing conditions prevail. In shape it is oblique-ovate, with a more or less decided point at the apex, deep purple in color, turning to a shiny jet black when fully ripe. The meat is firm and separates from the seed readily when pickled.

The Mission variety is superior for oil making, as well as for pickles. The tree is a vigorous, handsome, upright grower, suitable for borders, avenues, or windbreaks, as well as for general orchard planting. The strong tendency of the trees to make a vigorous upright growth rather than to spread requires that special attention be given to pruning where this variety is planted under conditions favorable for wood growth. It is one of the most resistant of all varieties to the olive-knot disease.

In some orchards, or with individual trees, much of the fruit varies in form from the normal to a more regular broad-ovate, with but little indication of the point at the apex. These variations in the shape of fruit are peculiar to the Mission variety. They are considered by many to represent distinct strains, while some contend that these characteristics are the result of local environment. Both forms of olives may be found on the same tree and even on the same fruit stem, although the predominating shape of the fruit on a given tree is decidedly of one form or the other. An effort to establish by bud selection or otherwise a strain of this variety which will regularly produce the better broad-ovate type of fruit is highly desirable.

MANZANILLO.

The Manzanillo variety was brought to this country from Spain and bears the Spanish name, meaning "little apple," probably so because the rather broad depression at the base resembles the base of an apple. The fruit is a little larger than the Mission variety and ripens somewhat earlier. For this reason it is a suitable sort for planting in zones where ripe olives may be harvested before the occurrence of fall frosts, which would injure the fruit of the later ripening Mission variety. The fruit is not as firm as that of the Mission and therefore requires more careful handling when picking and processing it. It is also considered inferior to the Mission for oil making. The flavor of the ripe fruit when pickled is, however, of very high quality and is claimed by some to be unsurpassed. The fruit is of a regular rounded or broad-ovate shape and its color is a rich dark purple, changing to deep bluish black when fully ripe.

The tree is a vigorous grower and inclined to be broad and spreading, a shape which is always desired.

ASCOLANO.

The Ascolano olive was brought from Italy. It is one of the largest fruited varieties grown in this country, being a little larger than the Sevillano. On account of its large size it has been used mainly for pickling. The fruit is very tender and requires special care in handling. When ripe it is a deep wine color rather than black. In shape it is a broad oval except for an inconspicuous point at the apex.

SEVILLANO.

The Sevillano variety is grown to some extent in a number of localities on account of its large fruit. It is claimed to be the large olive imported from Spain and known here as the "Queen." When properly grown its fruit is one of the largest produced in this country and is said to reach a greater size than when grown in Spain. It is of a rather long oblique-oval shape, resembling the Mission, is attractive as a green pickle, and makes a ripe pickle of fair quality, although if allowed to get ripe on the tree it is tender and easily bruised and so soft after processing that it must be harvested when only a thin blush of red is present in the skin. It is usually pickled when a yellow or straw color has developed and before a blush of red appears, and sometimes while green in color, even before signs of maturity are present.

The Sevillano is one of the most frost-tender varieties in common cultivation, so far as injury to the fruit is concerned. The tree is vigorous and is considered a good bearer. Like the Ascolano, its greatest point of recommendation for commercial planting is the large size of the fruit. The demand for large fruit in the eastern markets of the United States has resulted in stimulating the planting of the Ascolano and Sevillano varieties, so that these trees have of late years been very much in demand.

REDDING.

The Redding (*Redding Picholine*) variety was introduced from France and widely planted for the production of oil under the mistaken belief that it was the true Picholine of that country (California Ex. Sta. Rpt., 1898–1901, p. 271). It is still cultivated where the old orchards have not been grafted to other varieties or grubbed out, but no new plantings are made except to produce rootstocks for other varieties. The trees are vigorous growers and succeed under a wide range of conditions. It is an easy variety to graft. The fruit is very small, oval in shape, and of a deep bluish black color when ripe. Though the variety is exceedingly prolific, the fruit is too small for pickling and is used entirely for oil.

NEVADILLO.

The fruit of the Nevadillo (*Nevadillo Blanco*) variety is a little smaller than the Mission. Its shape is oval and regular except that it is somewhat blunt at both ends. When ripe it is a deep shiny black with a thin bloom. The ripe pickles are of good quality and flavor, and the fresh fruit returns a high quality of oil. It is too small to be considered first class for pickles. This is one of the first varieties to be injured by cold, and it is not being planted to any considerable extent at present.

PROPAGATION.

THE USE OF SEEDS AND CUTTINGS.

The olive may be propagated by seeds and cuttings or by budding or grafting. As seedlings do not come true to the variety and therefore do not produce a uniform type of fruit, they are grown only for stocks on which to bud or graft. By far the greatest portion of the olive orchards in the southwestern United States have been grown from cuttings, and this method of propagation is still in use by most orchardists and nurserymen. The reasons given for preferring this method are that but little skill is required in making the cuttings and that the trees are more quickly and cheaply grown, at least to a size suitable for setting in the orchard, than budded trees. It is claimed by some that by budding or grafting a seedling stock, a tree superior to one grown from a cutting may be produced.

The great number of orchards which have given satisfaction when trees grown from cuttings were planted allay the doubts of most planters, however, regarding the success of such trees.

For making cuttings, soft tender tips of branches or older hardwood are used. Nurserymen who require a large quantity of olive trees for their trade and propagate them by cuttings often use the branch tips, as it is difficult and expensive to secure hardwood cuttings of suitable size in sufficient number. They are also usually equipped with the necessary lath houses or other suitable means for furnishing the shade and protection from wind required by the young cuttings and for keeping in proper condition the beds of sand in which the cuttings are placed. About 4 inches is the usual length for making softwood cuttings. The tips selected should be those that have completed their length growth and are becoming firm but are not too hard. The condition of the growth, therefore, rather than any particular period of time, determines when the cuttings should be made. When preparing a cutting for planting the cut is made just below the node (the region where a leaf occurs), the same as for other plants. The two lower leaves are then removed and the others cut back about one-half their length. The cuttings are then placed in the sand bed rather close together, where they remain until roots have started, which under favorable conditions is but a few weeks. They are then transplanted to nursery rows or beds, where they are left until they are ready for planting in the orchard. It is claimed by some that trees thus grown have a better root system than those grown from large cuttings.

For making hardwood cuttings, branches three-fourths of an inch to 1½ inches in diameter are usually chosen, although smaller or considerably larger ones may be used. Such cuttings are generally made 14 to 16 inches in length.

As with most other trees, the best time for making hardwood cuttings is when the wood is most dormant, which is during January and February. After the cuttings are made they are commonly tied in bundles, then placed in a trench, and covered with moist soil or other material to encourage callusing. When the soil becomes warm in the spring, they are placed a few inches apart in the nursery row, being planted 10 or 12 inches deep, so that only one or two buds project above the surface of the ground. Rooting takes place readily under favorable conditions. The sprouts which grow during the first season are allowed to remain during that season. Then the best one for developing a tree is selected, and all the others are cut off. Growth in the nursery row during the second season follows.

TOP GRAFTING.

Top grafting is possible on olive trees of any age, and may be done at almost any time of the year with considerable success, although the best time to graft is just as growth starts in the spring. This method of changing an orchard from one variety to another was practiced in many cases in California during the transition period when the demand for fruit suitable for pickles was superseding that for the manufacture of oil and small-fruited varieties were replaced by large-fruited ones (fig. 8).

Both grafting into the stumps of large branches and budding into new shoots, which are allowed to grow for a year or so after the tree is cut back, are common practices (figs. 9 and 10). In preparing the tree for grafting, the limbs to be replaced by the new variety are cut off at any desired height by making a smooth, slightly slanting cut which will heal over quickly and not permit water to stand on the cut surface. The usual custom is to cut back only a portion of the top at one time, for fear of giving too great a shock to the tree, and the remaining branches are cut back the following year. If branches are to be left at the time those to be grafted are cut back, they should be selected so as to give as much shade as possible to the remainder of the tree (fig. 11). A coat of whitewash should be applied immediately to the trunk and stumps of branches to be grafted as a protection against sunburn (fig. 12).

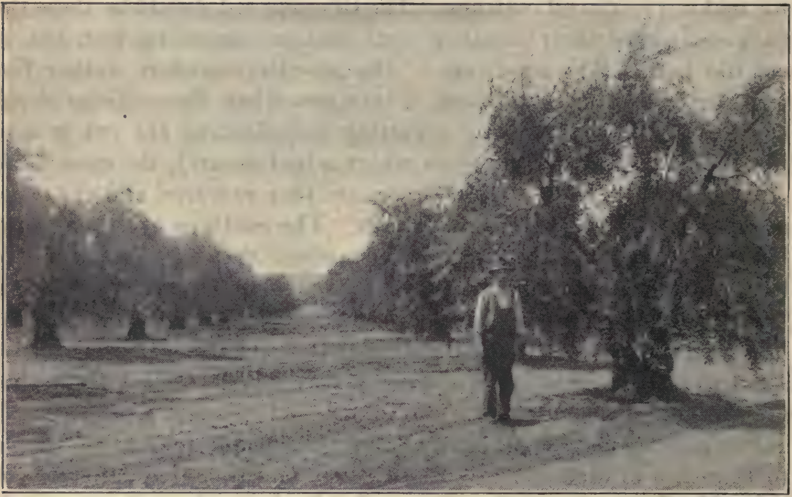

FIG. 8.—An olive orchard, originally of the Nevadillo variety, planted about 1890 near San Fernando, Calif. The trees, as they appear here, consist of 6-year-old Ascolano grafts, the original trees having been top-worked to the latter variety. (Photographed in May, 1920.)

The cutting back of the branches is usually done in late winter; and the grafting, when the trees start growth in the spring. As large wounds on the olive are inclined to heal over quickly and without leaving a permanent weak place in the branch at the point of grafting, larger branches may be removed than could be safely done with many kinds of fruit trees. This makes it possible to establish the new head low, which is always desirable with the olive, as the expense of harvesting the fruit is thereby lessened.

Where a large branch is removed, two or three scions are grafted in, spaced equally distant around the stump, to insure rapid healing over the stump and to furnish a more satisfactory number of branches for forming the new head than if one scion were used. This also insures to some extent against a total loss by the wind breaking the young branches.

Both cleft and bark grafting are practiced successfully. Scions of about one-fourth of an inch in diameter and bearing two to four buds are considered most satisfactory. These should be placed so that the upper edge of the beveled surface of the scion fits firmly to the upper edge of the stump, and the union is tightly bound with cord or tape and protected from water with a coat of grafting wax. Support should be given the new growing branch to prevent it from being broken off by the wind. This may be done by placing a long stick beside the scion and tying it firmly to the old stump and the new branch.

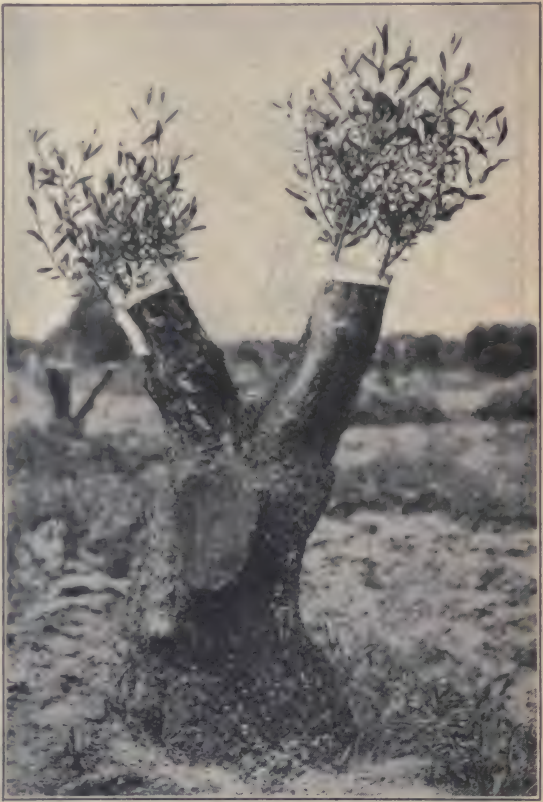

FIG. 9.—One-year-old olive scions in a 30-year-old stump. (Photographed May 12, 1920.)

TRANSPLANTING.

As the olive is an evergreen tree and is grown in sections where only light freezes occur, transplanting may be successfully done at almost any time of year, although the time accepted as the most satisfactory for transplanting this tree is after the soil has become thoroughly warmed in the spring, or during the period from about March 1 to May 15. If the earth is cold, the trees may fail to start growth for a considerable time, and some of the weaker ones may die. Only trees which have been well grown and have good root systems should be planted. Good-sized holes should be made in soil that has been thoroughly prepared to a good depth and the tree

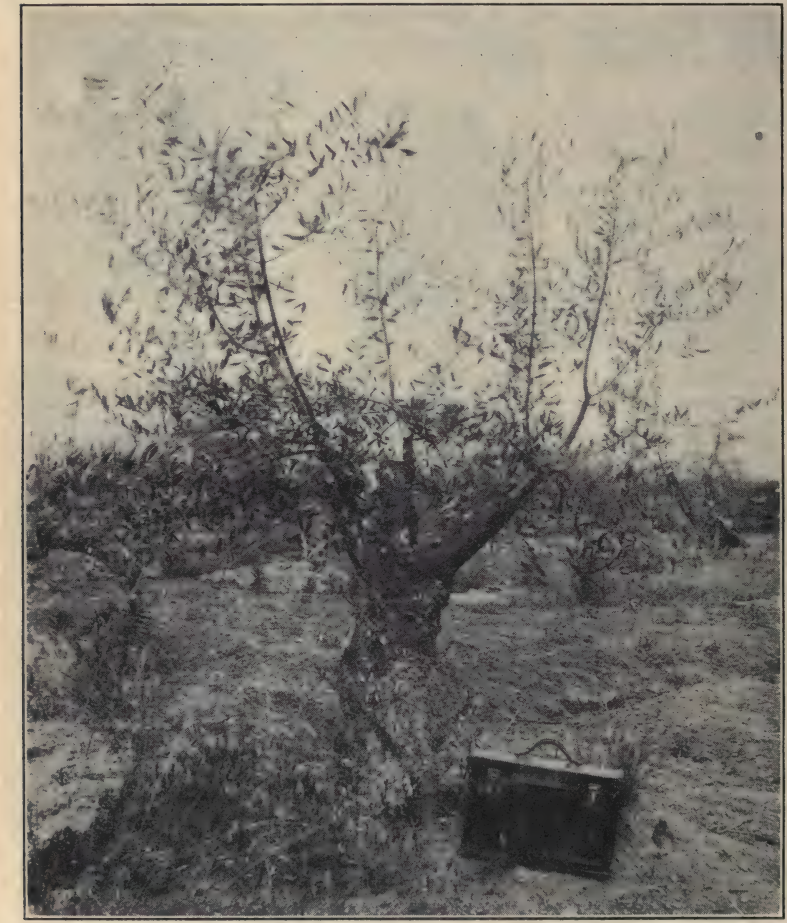

Fig. 10.—Scions that have made a growth of three seasons in an old olive tree near San Fernando, Calif. (Photographed in May, 1920.)

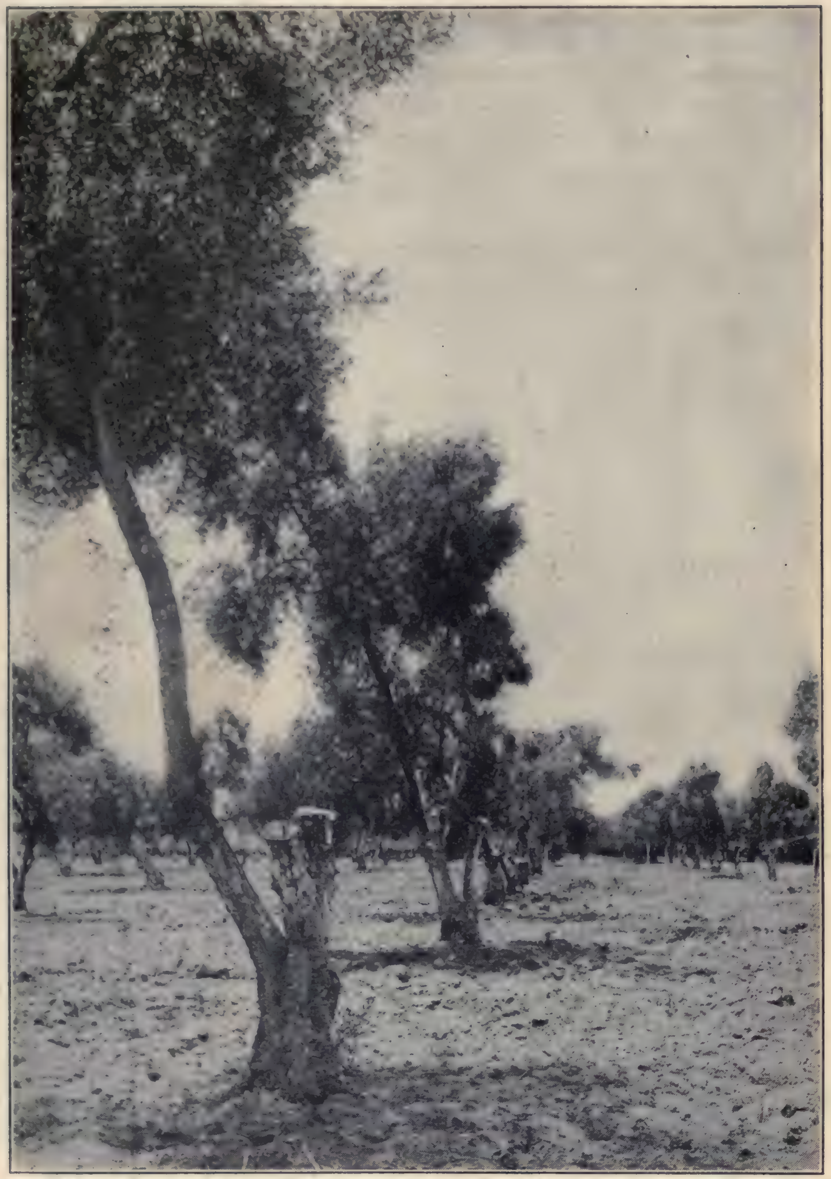

FIG. 11.—Olive trees 30 years old near San Fernando, Calif., being grafted over to another variety. The view shows the trees during the first season after the grafting was begun. Another year, when the scions have become well established, the remaining limb will be cut off and grafted. One main limb is left in order to maintain the vigor of the tree while the scions are becoming established. After they are established they will maintain the tree, so that the limb which now remains can be safely cut off for grafting the following year. (Photographed in May, 1920.)

placed a couple of inches deeper than it grew in the nursery. Well-pulverized moist earth should then be filled in around the roots. Olive roots dry out quickly when exposed to the sun or wind, so it is important that they be kept moist and covered until ready to be placed in the hole. As soon as the trees are planted they should be well watered, and the trunks which have been well shaded in the nursery by surrounding trees will now need artificial protection from the sun. A heavy coat of whitewash is valuable, but the tree protector manufactured for this purpose is more satisfactory. If thrifty trees are selected and the work of planting well done, the growth should start within a short time.

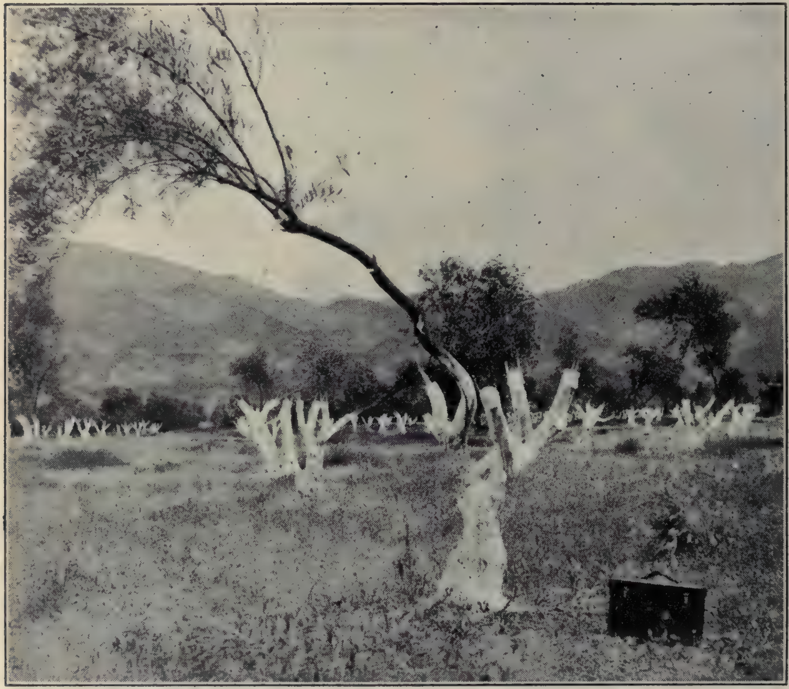

FIG. 12.—Recently grafted olive stumps whitewashed to prevent injury from sunburn. (Photographed in May, 1920.)

DISTANCE TO PLANT.

The distance for planting olive trees varies considerably in different localities and with individual orchardists, although the common distance is about 25 feet each way. Where conditions are conducive to a heavy wood growth, 30 or 33 feet, and in extreme cases even 40 feet, has proved to be not too far, for where the branch and leaf growth is very heavy much of the lower portion of the tree is deprived of sufficient light if too close planting is practiced (fig. 13).

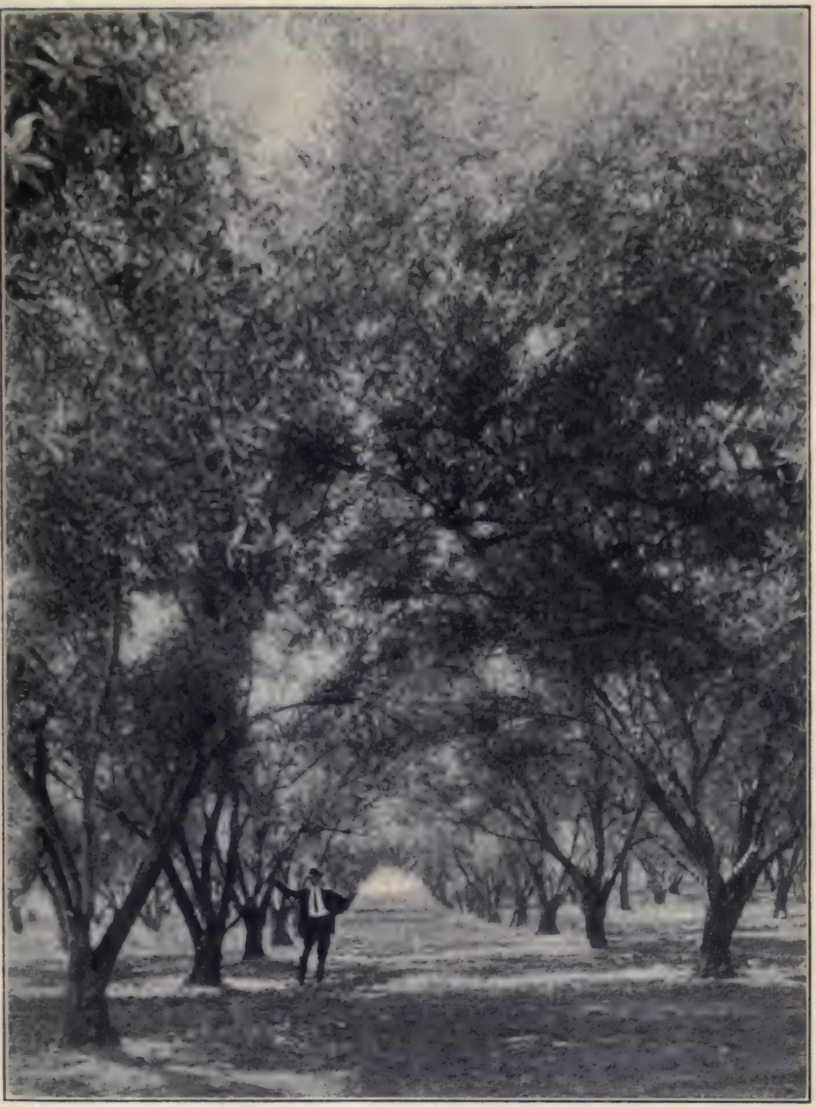

FIG. 13.—Old olive trees of the Mission variety which were planted too close together. As a result the tops have become very high, thus making the harvesting of the fruit difficult and expensive. (Photographed in May, 1920.)

Where olive trees are used for windbreaks, 18 to 20 feet is a good distance (fig. 14). For borders or avenues (fig. 15), for which purposes they are very ornamental and under good culture are productive, the local conditions and the effect desired must determine the distance of planting.

Where too close planting has been practiced, growers have in some instances removed alternate trees with good effect, but planting an orchard with this end in mind is not desirable (fig. 16). The olive comes into profitable bearing rather late, especially on soils where the tree makes a heavy wood growth, so when planted at normal distances one would secure only a few harvests before the trees would have to be removed, and those remaining would have been crowded into an unsatisfactory upright growth.

The transplanting of large olive trees removed from orchards in order to increase the distance between trees has resulted in an excellent stand and a satisfactory growth of transplanted trees (figs. 17 and 18). This result has followed even where the limbs and roots of the removed trees have been cut back to short stumps (fig. 19).

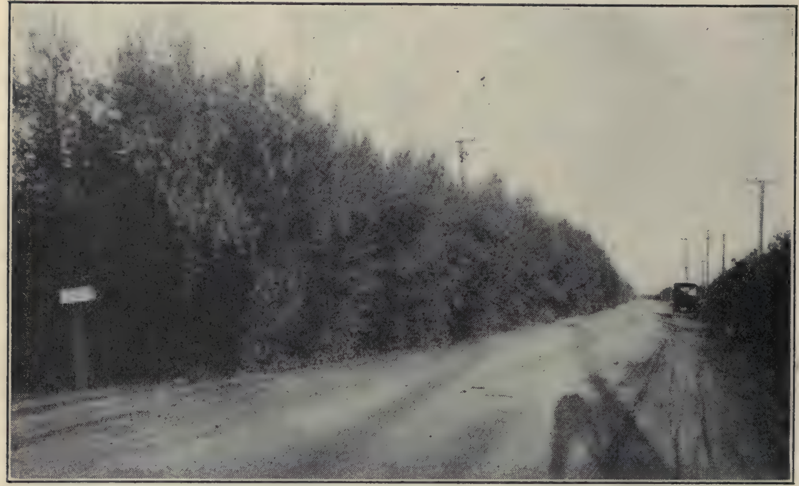

FIG. 14.—A row of unpruned olive trees near Exeter, Calif., which serve as a windbreak and dust screen. (Photographed in March, 1920.)

INTERPLANTING.

Interplanting olive trees with deciduous fruits, grapes, and annual crops is a common practice while the trees are young and where the soil is fertile and there is an abundance of water (fig. 20). Peaches, apricots, and plums are among the most satisfactory fruit trees for interplanting, as they come into heavy bearing early and will withstand heavy pruning and can therefore be retained for a number of years without causing an unsatisfactory development of the olive tree. Annual crops may also be used, but the planting of them as well as of other fruits should be done with caution, so as to avoid undue competition for soil moisture and plant food between the olive trees and the interplanted crop. Interplantings should therefore be used only where moisture and plant food are plentiful, or, in case of an annual crop, where the planting is restricted to narrow strips between the olive rows (fig. 21).

CULTIVATION AND IRRIGATION.

In the warm dry regions, where most olive plantings have been made, cultivation is very necessary for the conservation of soil moisture, for maintaining a surface mulch, and for keeping the land free from weeds. Since the soil in which olives are grown is, for the most part, loamy and friable, a satisfactory tilth is not difficult to maintain.

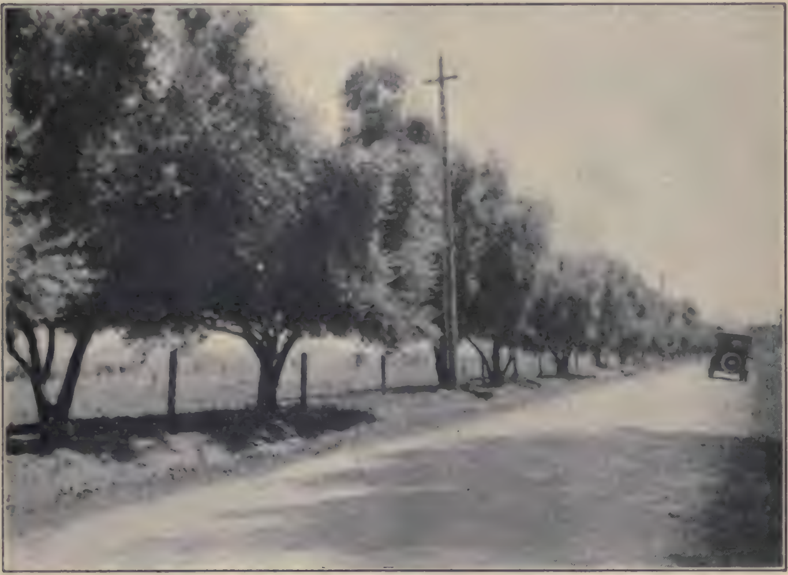

FIG. 15.—A roadside planting of olive trees of the Mission variety near Phoenix, Ariz. (Photographed in April, 1920.)

The system of cultivation generally followed in a commercial olive orchard is to plow once during the winter or early spring and give only shallow stirrings thereafter. The plowing should be at a moderate depth and finished a few weeks before the blossoms appear. Subsequent surface stirrings should then be given with a cultivator or disk harrow in order to maintain a soil mulch and destroy weeds which would rob the trees of the surface moisture. In this way the subsoil is well protected against drying out and the upper soil kept in good mechanical condition for new feeding roots, which will grow upward into it in the early spring.

While a high humus content is not desirable in the olive orchard, a moderate supply is needed to preserve a good physical condition of the soil for root growth and to maintain moisture. To secure this it is the common practice to encourage a cover crop of wild vegetation during the winter or, occasionally, to sow in the fall one of the legumes commonly used for cover crops and allow it to grow until time for plowing in the spring. It is claimed that bitter clover (*Melilotus indica*) and common vetch (*Vicia sativa*) have given the best satisfaction for this purpose. It is important that this crop be not left in the spring until it has robbed the soil of too much moisture, as the period before blossoming is considered the most critical so far as setting a good crop of fruit is concerned. On the return of warm days in the spring, when evaporation of the soil moisture is considerable, the combined effect of the roots of the cover crop and of the olive trees, the roots of which are inclined to be superficial, dries the surface soil quickly. This will result in difficulty in plowing, and the plowed soil will be left in a rough, cloddy condition if plowing is delayed.

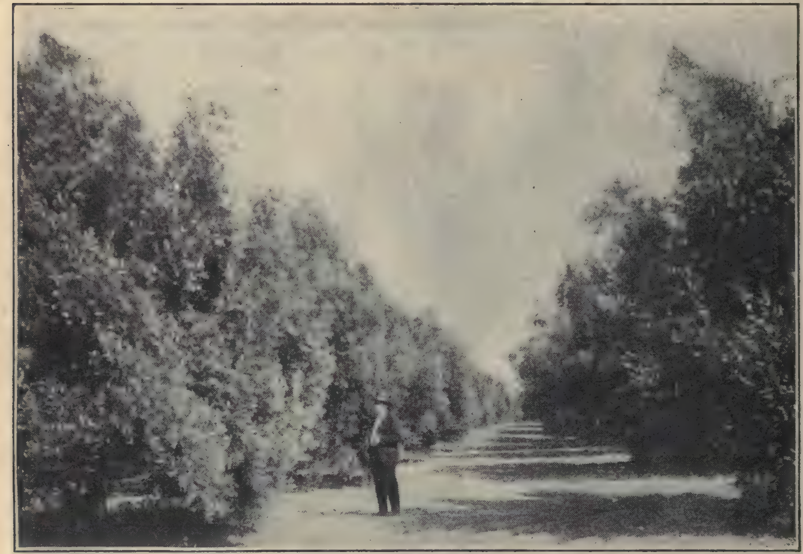

FIG. 16.—An olive orchard near Fontana, Calif., which was originally planted too close. This view shows the orchard five years after alternate rows of trees had been removed to relieve the crowded condition. The tree development and the production are now good. (Photographed in May, 1920.)

The frequency with which irrigations are made and the quantity of water used differ, depending upon the texture and depth of the soil and on weather conditions. In the well-drained sandy loams, where water filtration is good and considerable water, as well as plant food, may be lost by seepage, frequent light or moderate waterings are preferable to infrequent heavy ones. The vigor of the twig growth

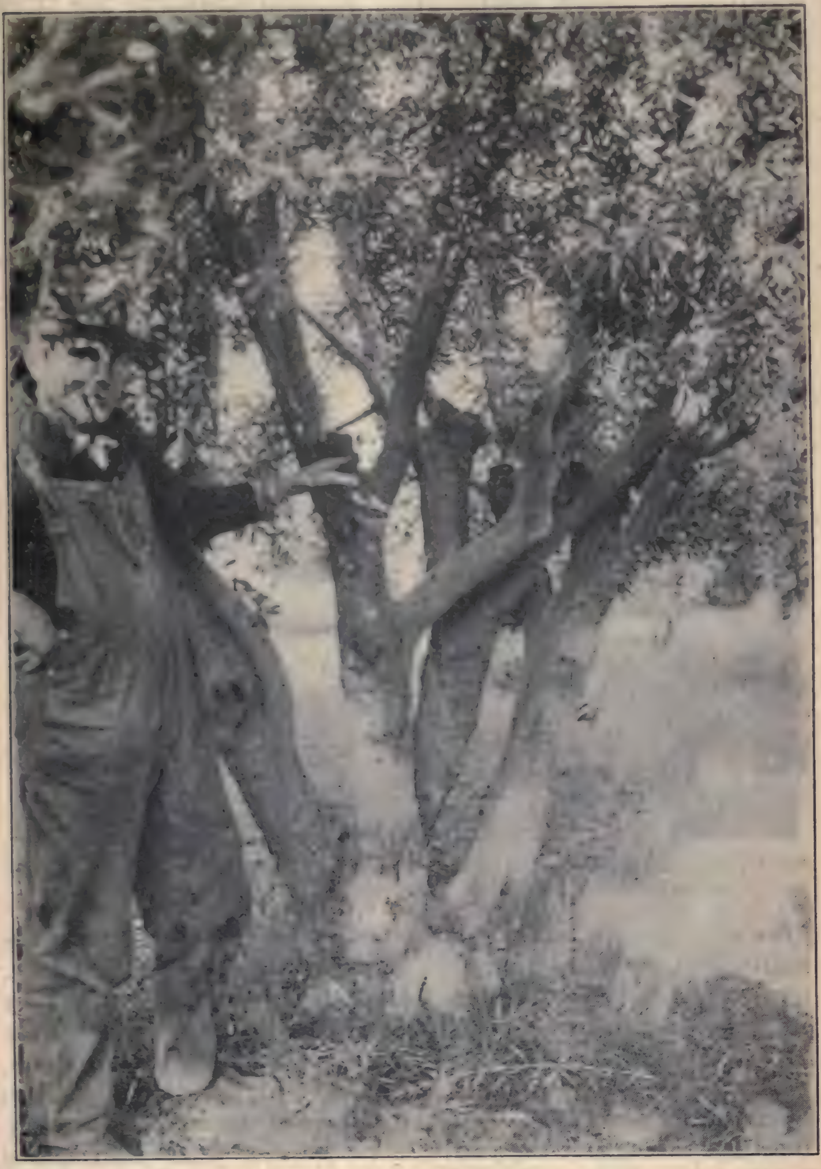

FIG. 17.—A 12-year-old olive tree of the Mission variety which was transplanted in 1912. At that time the tree was cut back to the height indicated by the stubs at the level of the man's hand. The tree as here shown has grown for eight seasons since it was transplanted.

of the current season determines to a large degree the quantity of fruit which will be produced the next year, and a heavier and more thrifty twig growth results where frequent waterings are given rather than where the soil is soaked and later permitted to dry out. In the moderately deep and fairly well drained soils, where by far the most olive orchards are found, every 30 days is considered by many successful orchardists to be sufficient, but by some every three weeks is thought not too frequent for the economical watering of bearing olive orchards. Where water is scarce and applications can not be made at regular intervals it will be best (where possible to do so) to irrigate two or three weeks before the blossoms appear, again when the fruit is one-third to one-half grown, and again when it is nearly full grown, or during the first part of September. At least, the first and last of these irrigations should not be neglected, as they are considered to be most critical periods with respect to both the current crop and the development of the tree for the following one. When fall and early winter rains are light, an irrigation should be given during this period, as the olive is an evergreen and therefore functions throughout the year. As evaporation is slow during the winter, one early irrigation will usually be sufficient for an entire dry winter if the soil is in good tilth.

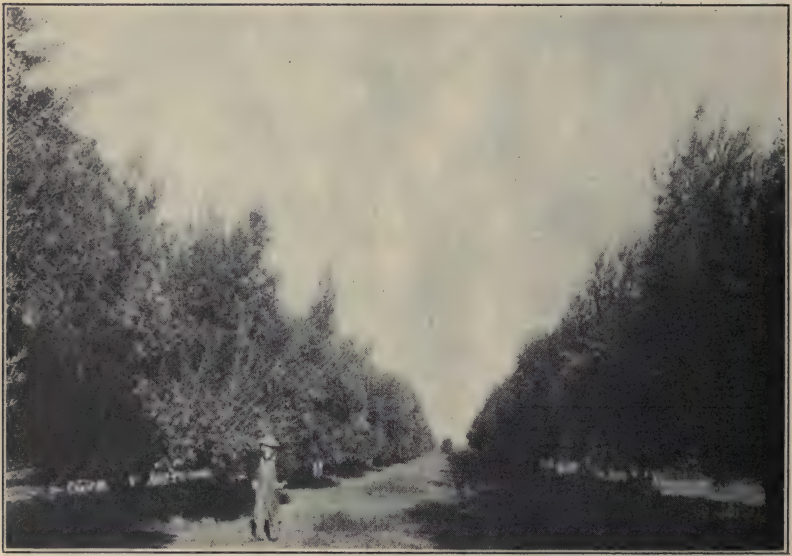

FIG. 18.—An olive orchard of the Mission variety near Strathmore, Calif. The trees were transplanted in 1912 and are now 20 years old. (Photographed in March, 1920.)

As with other fruits, care must be taken that water drains out of the lower soil strata and also from all low areas; otherwise seepage water will collect in such places and cause serious injury to the roots.

It is advisable, however, to leave unplanted the depressions where water and air drainage are faulty.

Irrigations that are too frequent or too heavy often prove detrimental where soils are underlain with hardpan or a stratum of poorly drained material which prevents the downward movement of water, as olive roots are sensitive to excessive moisture. Thorough cultivation to maintain a surface soil mulch for the purpose of conserving moisture and the infrequent and light irrigations should prove profitable on such land.

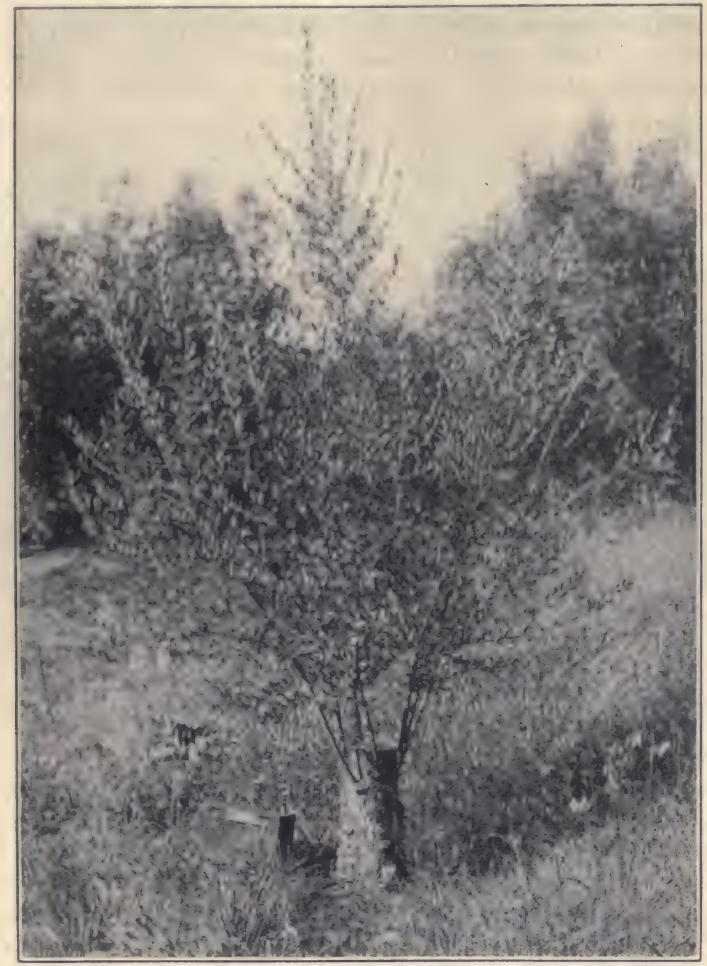

FIG. 19.—An old stump of a Mission olive tree near Oroville, Calif., showing sprouts grown during three years since it was transplanted. (Photographed in April, 1920.)

Olives are, as a rule, planted on friable soils where irrigation water moves downward rather rapidly and the feeding roots of the trees are inclined to be near the surface; hence, the use of a number of irrigation ditches between the rows, through which the water may be passed and the entire surface soil wet within a short time, is generally more satisfactory than where fewer ditches necessitate many hours for the percolation of the water through the soil (fig. 22). The use of only one or two ditches to the row often results in leaving broad areas with insufficient moisture between the rows, causing an excess of water to collect in low places and in subsoils which are naturally retentive of moisture.

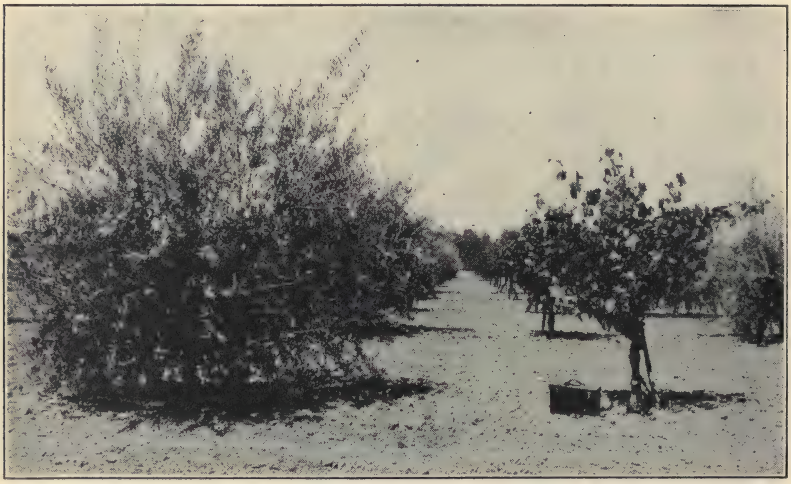

FIG. 20.—A five-year-old olive orchard of the Manzanillo variety interplanted with Sultanina (*Thompson Seedless*) grapevines near Phoenix, Ariz. (Photographed April 30, 1920.)

FERTILIZATION.

Most soils on which olives have been planted in the region under consideration are thought by many to be sufficiently supplied with plant food for satisfactory olive production. Among olive growers, however, there is a general belief that fertilizers are needed, and the few who have consistently applied them over a term of years claim to have been well repaid with increased crops. The elements most needed, the quantity required, the time of application, etc., are, however, unsettled questions, as systematic tests to determine the need for the elements commonly used in fertilization have never been carried on or even undertaken in olive orchards in this country. Such tests would be of great value to the olive industry.

PRUNING.

The objects to be kept in mind in pruning the young trees are (1) to establish the form of tree which can be most conveniently cultivated; (2) to provide for a broad, low bearing surface from which fruit can be economically harvested; (3) to favor new growth on all parts of the tree and admit light for its development; (4) to remove interfering or cross branches; and (5) to maintain shade for the protection of the large limbs against sunburn. Although the growing of many varieties on a large number of soil types and over a broad range of climatic conditions has resulted in considerable divergence of opinion as to the most profitable methods to follow in pruning, pruners should keep the above ideals before them and let the severity of the pruning be determined by the needs of the individual tree.

Before the nursery tree is set in the orchard it should be headed back severely, leaving but 3 or 4 inches of each of the main branches. It is well also to remove at this time all branches which will not be required for forming a desirably shaped tree. For the branches which are to form the top of the tree only strong upright ones should be selected, and these should be spaced a few inches apart along the trunk of the tree and distributed at distances as nearly equal as possible around it. When the tree as planted consists of a single stem it should be cut back to the point where one wishes the main branches to develop, which with most growers is 20 to 24 inches above the ground. Branching in many orchards has been encouraged at but a few inches above the crown, but this is not considered wise, as cultivation is made more difficult thereby. Before planting, the roots should also be shortened to a length permitting them to be placed in the hole without bending or twisting, and roots injured in digging should be removed at the point of injury. This will be about all the

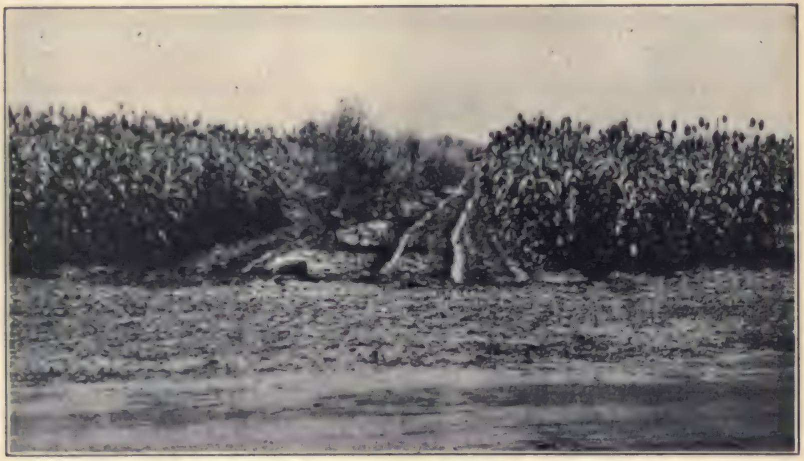

FIG. 21.—A catch crop in a young olive orchard of the Mission variety near Lindsay, Calif. (Photographed in August, 1920.)

pruning necessary if the four or five main limbs branch as desired during the next few seasons, but in places where the upright growth of these limbs is very vigorous and they branch but little, they should be cut back during each of the next two or three winters to the point desired for the next branching.

For the method of pruning to be followed in succeeding seasons much will depend upon local conditions. On light or shallow soils, where wood growth is slow, little, if any, heading back would be done; severe cutting back will usually result in seriously stunting the growth of the tree. Pruning under these conditions should consist for the most part in the removal of interfering branches and in thinning out where small branches are too numerous to permit a thrifty development of new growth. This method will apply more especially to varieties which are naturally inclined to be low and spreading in their habits of growth.

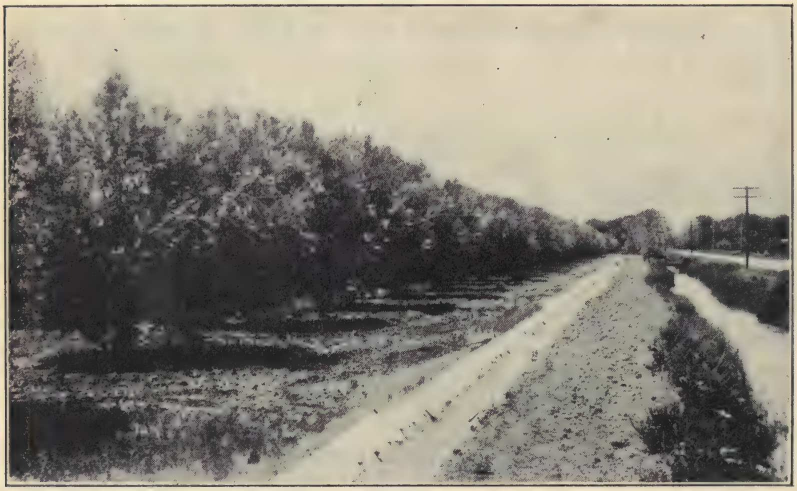

FIG. 22.—A 7-year-old olive orchard of the Mission variety, near Phoenix, Ariz., showing good growth; also showing the main irrigation ditch and the head ditch, with small outlets for the water into the orchard rows. (Photographed in April, 1920.)

In very fertile soil where the central or main branches make an excessive upright growth and are not inclined to form strong satisfactorily spaced lateral branches, the cutting back of these central branches each winter for a few years, to induce the growth of a greater number of framework branches, is desirable. In a few localities the conditions for wood growth are so favorable that the upright growth of a few main branches, which develop where little or no pruning is practiced after the first year, continues year after year at the expense of the lower lateral branches until within a few years the main portion of the crop must be harvested from tall ladders and at an excessive cost. Also, the shading of the interior part of the tree prevents growth there and leaves the main body but barren poles. The developing of a broad, low fruit-bearing surface by severely cutting back the rank interior branches for two, three, or four successive winters, to induce branching, has resulted successfully, although the trees have probably been delayed in coming into bearing.

Conditions are such that in by far the greater number of olive orchards the growth of the tree will come well between these two extremes of too little and of excessive upright growth, and each grower must decide as to the severity and regularity of pruning necessary to develop a strong, broad tree frame and maintain the other conditions already mentioned.

Where the growth of the young tree is so slow that no pruning is necessary to secure the open top and spreading shape, the crop will usually be too light to be profitable, and orchard management along lines of cultivation, fertilization, irrigation, or drainage should be employed or adjusted to induce a more vigorous growth.

In all pruning of the bearing tree it must be remembered that the fruit is borne on the previous year's growth only, and the crop will be unsatisfactory if this wood does not make a thrifty, vigorous development. When no thinning out of small twigs has been practiced, thick brushes of slender drooping growth with but a very few inches of new wood often result. These masses should be thinned out to admit light to the remaining wood. This is more especially true where the tree is making poor or only fair growth. Where, owing to exceptionally favorable natural conditions or extra care, the trees are very thrifty and vigorous and are making considerable annual growth, the small branches do not droop to a very objectionable extent, the smallest, weakest twigs are crowded out, and little, if any, thinning is necessary.

The olive tree is naturally very long lived and reaches a large size, and its period of profitable production should continue over many years. Therefore, the foundation branches should be so developed and the tree tops so kept within bounds by regular thinning that heavy crops may be borne and economically harvested.

Of the two principal varieties, the Mission and the Manzanillo, the former is much more inclined to make a tall, slender growth; it therefore requires considerably more attention at pruning time than the latter.

Trees in many orchards where conditions for wood growth are favorable have reached a height where the harvesting of the fruit is so expensive that the orchard can not be maintained at a satisfactory profit, and heavy cutting back of the tree tops has been practiced to establish the bearing surface nearer the ground. Such pruning should be done with caution, as the production of the trees will be held back a few years by this practice. When the top branches are severely and uniformly cut back a very rapid upright growth of new branches will follow, and usually at the expense of fruit production. By removing some of the large branches and cutting others back to laterals, but not too severely, a more moderate growth of new wood is encouraged. This also develops the low branches by admitting light and secures a larger bearing surface. The latter practice is generally looked upon as the more satisfactory method of the two. The reheading of large, thrifty trees should in all cases be followed by the frequent thinning of some of the vigorous upright-growing branches which follow the pruning and by the shortening of others, to keep the new head within bounds.

The open-headed tree, often termed goblet or vase shaped, is the form favored by some growers. This form is secured by cutting out all central branches after the main limbs have become well established and allowing a heavy growth of lateral branches to develop on the main branches, which grow from the tree trunk at an angle, but not permitting them to fill the center of the tree. While the yield of such trees will probably not be as heavy under all conditions as if some of the central branches were allowed to remain, the loss from the injury caused by the black scale will be far less, owing to the admission of an abundance of noonday sunshine. In sections where this insect is troublesome this method of pruning is often practiced advantageously.

PROTECTION OF LARGE LIMBS FROM THE SUN.

Where large branches are removed in pruning or cut back for top grafting, thereby exposing the bark of the remaining large branches to the sun, such exposed places should be immediately covered with a coat of whitewash to prevent sunburn. The new growth which will appear all along the branches within a short time will soon furnish sufficient shelter from the sun.

EXPERIMENTS IN PRUNING NEEDED.

There is an urgent need for systematic experimental work in the pruning of olive trees. Such work has not as yet been carried on in this country, although there is no subject connected with olive production about which the grower is more keenly interested.

HARVESTING THE FRUIT.

As a rule, the ripening season extends from two or three to several weeks, depending for the most part upon the size of the crop, but also upon the locality and the variety. Where the crop is light it may sometimes be harvested all at one time. In the foothill sections of the warm interior valleys of northern California some fruit of the early-ripening varieties is sometimes ready for harvest early in October; but in some sections near the coast, where it is cool and often cloudy during the summer months, the picking season is often not over until some time in February. Three or four pickings are usually necessary where the crop is heavy, especially if the orchard lies within the range of the cool sea breezes, where ripening of the fruit progresses slowly.

As it is preferable from the standpoint of the processor to gather all the fruit at the same stage of maturity, as there is usually fear of the fruit being injured by freezing, and also as the orchardist wishes to keep his laborers employed after the harvest opens, harvests are made whenever there is sufficient fruit to justify them. Where a number of pickings are necessary, the harvest becomes very expensive, as the fruit ripens unevenly on all parts of the tree and the entire tree must be gone over at each picking, and except where trees are small much of the fruit must be gathered from ladders.

To obtain a uniformly good quality of ripe pickles, well-matured fruit is necessary. The most practical guide for the picker is the color of the fruit. Some canners of ripe olives, whose product is looked upon by many as the standard of excellence, insist upon having only deeply colored fruit for processing. However, as the fruit on the lower, shaded portions of the tree does not color as rapidly as it does over the outside branches, no color standard for picking can be strictly adhered to, and the picker must be guided also by experience. With modern methods of pickling olives the dark color may be developed even if the fruit is immature, but immaturity is always betrayed by the quality of the product, as the meat, instead of separating easily from the pit and being smooth and of a rich flavor, is hard and brittle, adheres to the pit, and is lacking in richness. While immature fruit is not satisfactory for making ripe pickles, overripe fruit is also unsuited for this purpose, as it is soft and becomes bruised during picking and processing.

Some large-fruited varieties become very tender upon ripening and must be harvested before they are fully ripe, to avoid serious loss by bruising during picking and processing. They are not allowed to remain on the tree after the first blush of reddish color appears.

A maturity standard based on the oil content has been suggested as follows:

> A minimum oil content of 17 per cent in the flesh is offered as a tentative standard of maturity for Mission olives and other common varieties except the Manzanillo, Ascolano, and Sevillano. A minimum oil content of 15 per cent is recommended as a tentative standard for Manzanillo olives. No standards for

> maturity are recommended for the large-fruited olives, Ascolano and Sevillano, which must be gathered when relatively immature. These olives, however, should not be sold under the designation "ripe."
>
> Because of the great variations noted in the composition of olives of the same variety grown in different localities, it probably will never be practicable to set definite and hard-fixed minima for oil in mature olives, and the proposed standards must be applied with caution.[5]

For making ripe pickles, careful handling of the fruit during harvest has been recognized for many years as of first importance. Badly bruised or punctured fruit can not be used for pickles and must be utilized for oil. The fruit is therefore gathered by hand and placed carefully in picking baskets or buckets and transferred to lug boxes for hauling to the pickling plant. Further to insure against bruises, some packers place some water in the picking buckets to serve as a cushion for the falling fruit. Stripping fruit from the branches with rakes and allowing it to fall on canvas spread under the tree is practiced occasionally by a few, but a low percentage of first-class products is expected from such methods.

While somewhat less care is taken in harvesting fruit which is to be utilized for oil making, it is recognized that only sound, well-matured fruit will render first-quality oil.

For making green pickles, which is a minor industry in this country, large fruits only are used, and these are gathered as soon as they are full sized or when a light-yellow color indicating approaching maturity appears, but before the pink blush develops in the skin.

When the processing plant may be reached in a day or so after picking, the fruit is shipped in lug boxes, but when several days are required for transportation, barrels are used and the fruit covered with salt water to prevent bruising and spoiling in transit.

GRADING AND PROCESSING THE FRUIT.

When the fruit reaches the pickling plant it is first run through a sizing machine and separated into different sizes. During the pickling process each size is treated separately, as olives of uniform size can be pickled more uniformly than fruits of different sizes handled together, and the pickles are more attractive when sized. Fruit of different varieties is kept separate throughout the pickling process. This is necessary, not only for marketing but also because the fruit of different varieties is different in texture and quality.

Canners of olives do not have a uniform size standard into which they grade their fruit, although it appears that this would be very desirable. The difference in size between grades with most packers is one-eighth of an inch in the narrowest diameter of the fruit. All small fruit, which is usually considered to be that below nine-sixteenths of an inch in diameter, is utilized for oil, and the fruit above that size is graded into a number of sizes. Many types of machines devised for sizing olives are in use. Some have screens adapted for separating the fruit of different sizes; others have rollers spaced at the desired distances, over which the fruit is passed, while another type has diverging rollers, but all adjustable for delivering the fruit sized according to the required diameter. Handling the fruit in this operation must be carefully done, and the sizing machine, whatever the type, must be adjusted to prevent bruising the fruit.

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[5] Hilts, R. W., and Hollingshead, R. S. A chemical study of the ripening and pickling of California olives. U. S. Dept. Agr. Bul. 803, p. 24, 1920.

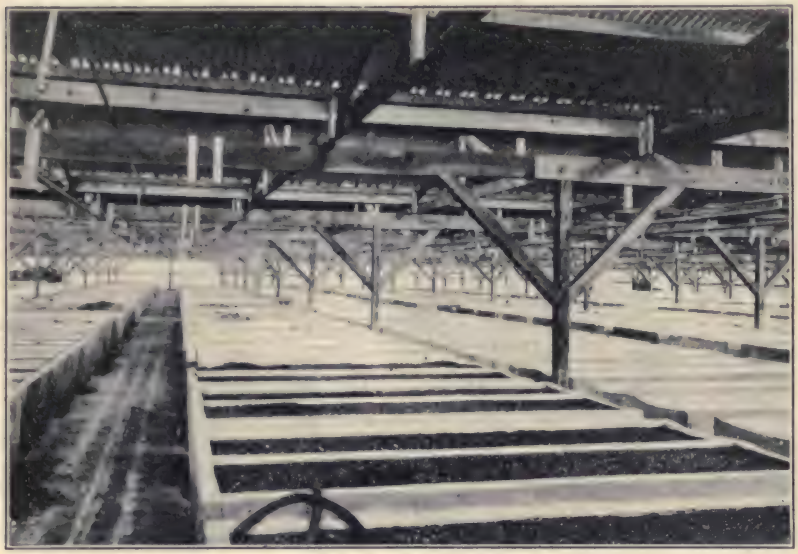

FIG. 23.—An olive pickling room, showing concrete processing vats.

From the sizer the fruit is conveyed to vats, where the pickling process starts. Wooden or concrete vats of many sizes are in use, although in the newer plants concrete vats are used almost exclusively (fig. 23). These vats are about 3 feet wide, 2 feet deep, and 8 to 9 feet long, a convenient size in which to give the fruit uniform treatment and to handle it easily with the least injury. Here the bitterness which is in the fruit when it comes from the tree is destroyed by soaking in a lye solution, and after the olives have been darkened by aeration and the lye removed by washing in fresh water the fruit is soaked for a few days in salt water. It is then removed from the vats, graded as to color, and canned with salt water after the bruised fruit is removed. The cans are now heated in a water bath or in retorts under pressure at a temperature somewhat above that of boiling water.

The California State Board of Health has recently decided to require that all ripe olives, before being offered for sale in that State, be held at a temperature of 240° F. for 40 minutes to avoid all possibility of bacterial contamination.

Some variation of the above method, which has been in use since the pickling of ripe olives was first practiced in California, is employed by most olive canners. Though the details of the method, as outlined, are not carried out in the same way in all plants and though some claim secret variations or additions to the customary treatment, the fundamental principles of the commercial method are well known.

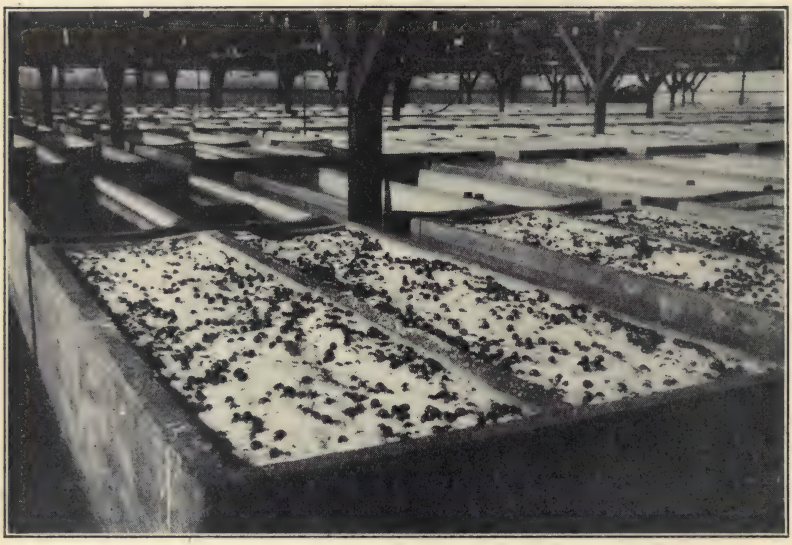

FIG. 24.—Olives curing in salt in concrete vats.

Ripe olives are cured also by soaking them in strong brine or mixing them with partially ground rock salt—processes in which no lye is used (fig. 24). In very recent years a considerable quantity of olives has been treated in this way in California. For these processes only very well ripened fruit is used, and from four to six weeks are usually required to render the fruit palatable. The product, which is somewhat shriveled in appearance and acrid in taste, is prized by peoples from the Mediterranean countries. It has not been adopted to any extent as a food by Americans.

Olives intended for green pickles must be taken from the tree earlier than those for ripe pickles and must not be aerated during the pickling process, as this would result in darkening the color of the fruit. Aside from these variations and a fermentation process to which the fruit is subjected to develop the flavor characteristic of green pickles, the method for making the green pickles is not different, except in a few respects, from that for making ripe pickles.

Those interested in the details of olive pickling and oil making may obtain information on the subject from Bulletin No. 803 of the United States Department of Agriculture, entitled "A Chemical Study of the Ripening and Pickling of California Olives."

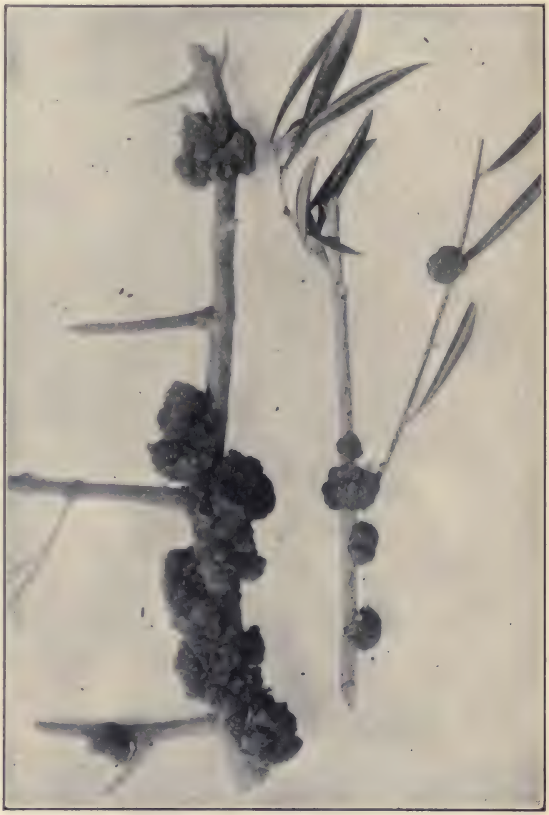

FIG. 25.—Branches of the Nevadillo olive showing olive knots. (Photographed in June, 1920.)

INSECTS AND DISEASES.

Insect pests and diseases which cause serious loss in commercial olive orchards in the United States are few in comparison with those which attack most other cultivated fruits. Among the insects that attack the olive tree in this country the black scale is the only one of importance, and among the diseases the olive knot is the most destructive, although others of minor importance are more or less common.

INSECTS.

Saissetia oleae Bern., or the black scale, as it is commonly known in olive-growing regions of the southwestern United States, causes greater destruction to the olive in this country than any other insect and is responsible for seriously curtailing the output of fruit in some localities. It does not confine its attacks to the olive, but feeds on a great number of both deciduous and evergreen plants which are widely distributed, making it exceedingly difficult to eradicate, and it must therefore be considered when olive plantings are contemplated. Fortunately, it does not thrive in sections where the summers are hot and dry, such as is the case in practically all of the olive-growing sections which are not cooled and moistened by sea breezes, and in such places spraying is seldom necessary for its con-

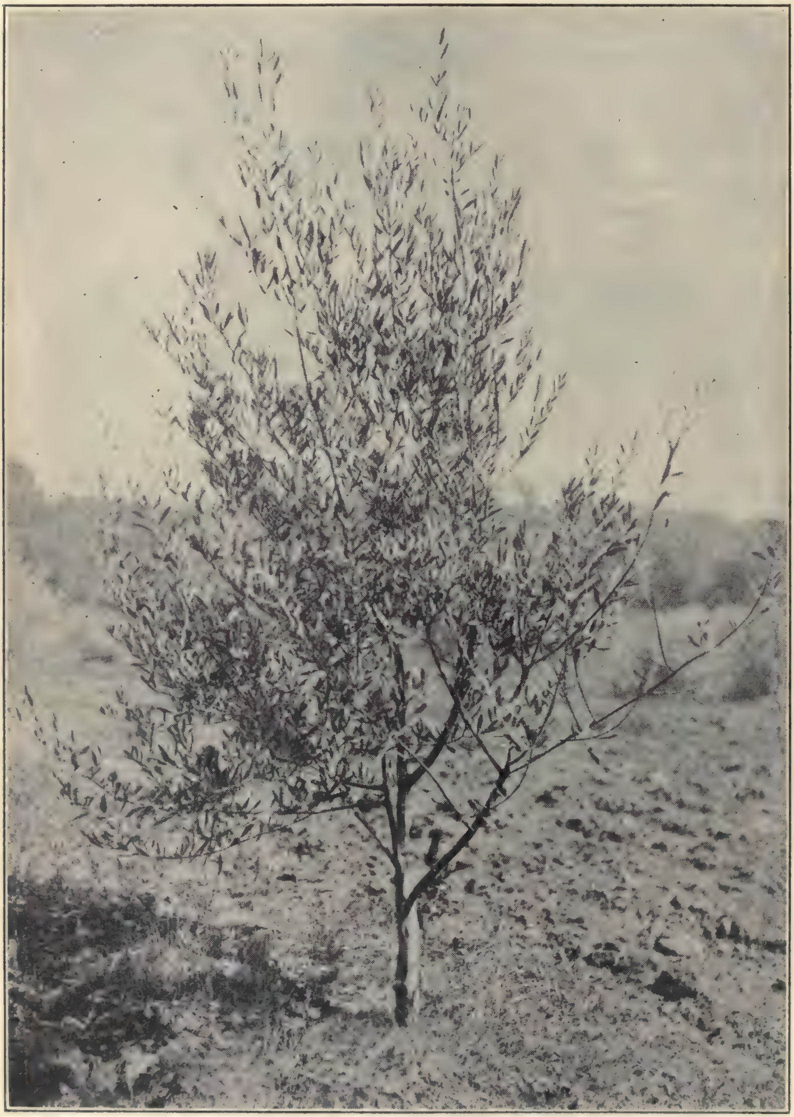

FIG. 26.—A thrifty olive tree for comparison with the one affected with die-back shown in figure 27. (Photographed April 3, 1920.)

trol. In the damper regions along the coast, however, the black scale and the black smut which accompanies it cause serious loss where preventive measures are not used.

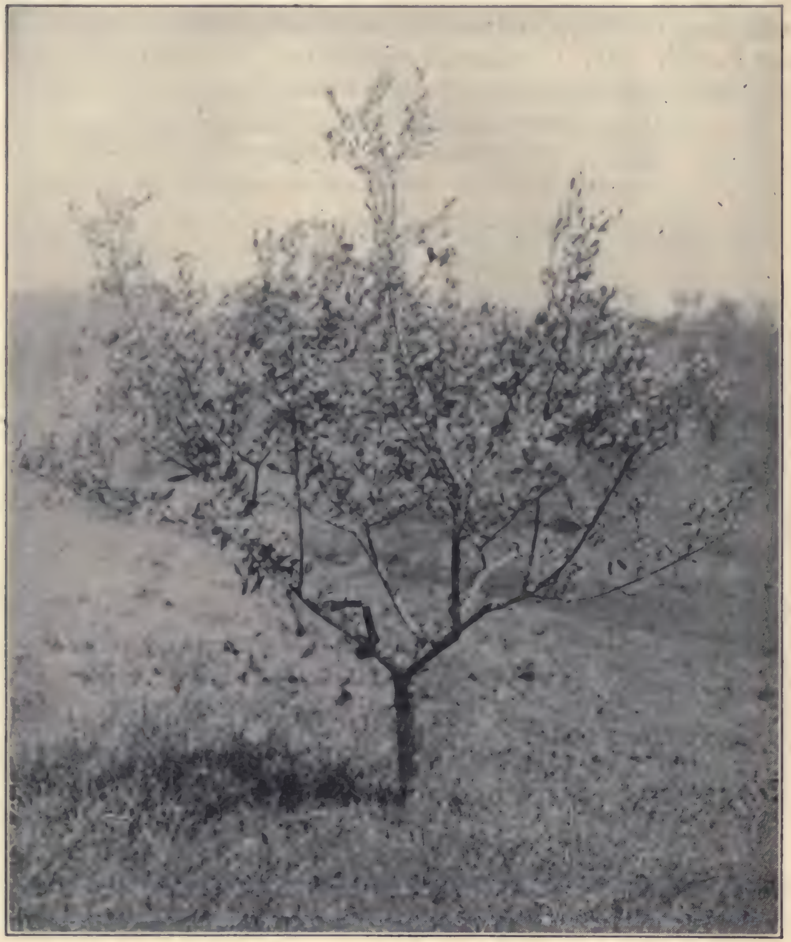

Fig. 27.—A 4-year-old olive tree affected with die-back. Compare this with the thrifty tree shown in figure 26. (Photographed April 3, 1920.)

DISEASES.

KNOT (BACTERIUM SAVASTANOI).

The disease which has caused the most serious loss in olive orchards is the olive knot (fig. 25), which is produced by a bacterium (*Bacterium savastanoi*). This bacterium attacks all parts of the tree, including the leaf and fruit stems, but is most harmful on small growing twigs and young vigorous trees. Its destructiveness is most marked in localities where it is warm and moist and conditions are favorable for a rapid tree growth. The best preventive measure known is cutting out the infected portions and disinfecting the resulting cuts, much as is done in pear-blight. As the bacteria come from the knots and are carried to other parts of the tree in wet weather only, their spread may be best prevented by pruning out infected branches before the winter rains occur.

The variety most seriously damaged by this disease is the Manzanillo, although the knot is common on a number of the small-fruited varieties grown for their oil. It is not, as a rule, a serious menace to the Mission, Ascolano, Sevillano, and other large-fruited varieties, the Mission being almost immune to it.

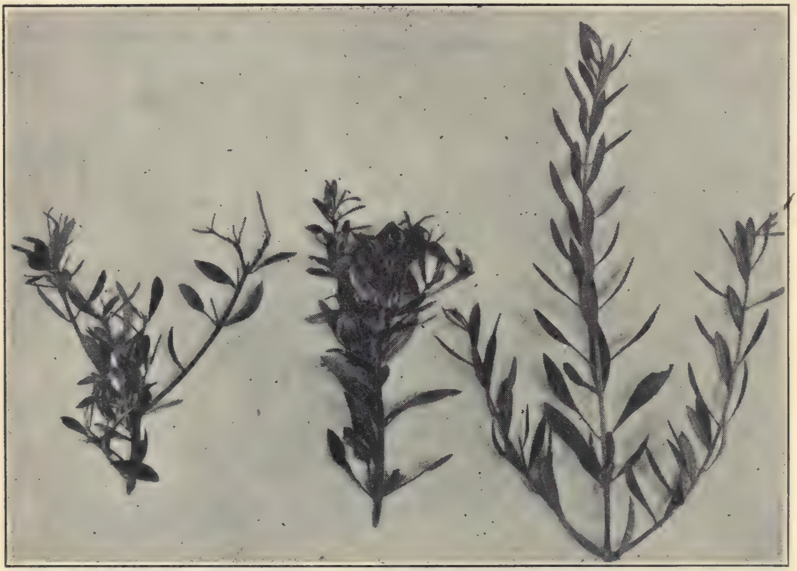

FIG. 28.—Olive twigs affected with die-back (at the left). The branch at the right is in a normal healthy condition.

DIE-BACK, OR EXANTHEMA.[6]

The die-back of olive trees, which has recently come into more or less prominence in a number of localities, causes the dying back of the twigs and branches. The growing tips of leading branches usually die first, and new growth starts from nodes below, and these, in turn, become stunted and die (figs. 26 to 28). Affected trees fail to bear fruit, and loss of a large portion of the tree, if not the entire tree, follows within a few years. The trouble is most common where subsoil drainage is faulty. Blasting, subsoiling, or otherwise opening the subsoil to permit a free circulation of moisture and air through it is thought to be the most practicable remedy.

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[6] Horne, W. T. Diseases of the olive. *In* Pac. Rural Press, v. 88, no. 3, p. 54. 1914. Some diseases of the olive in California. *In* Olive Jour., v. 1, no. 9, p. 4, 1917.

DRY-ROT.[7]

Attacks of dry-rot result in the shriveling and browning of spots in the flesh of the fruit, and in some seasons it causes considerable trouble. The diseased spots take lye during the pickling process more readily than the surrounding healthy tissue, and great care must be taken during processing if the affected fruit is to be used for ripe pickles.

Olive growers should be constantly on the lookout for destructive insect pests and diseases which cause preventable loss either to the tree or fruit. Both insect and disease problems should be referred without delay to either a State agricultural experiment station or to the United States Department of Agriculture for advice. The timely use of preventive or control measures may prevent serious loss.

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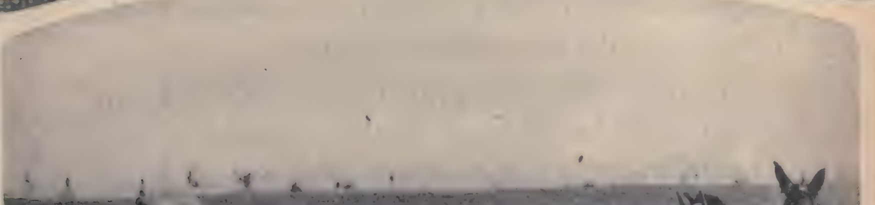
[7] The Olive Journal, vol. 1, No. 5, October, 1916, p. 7.

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1922

FARMERS' BULLETIN 1250

UNITED STATES DEPARTMENT OF AGRICULTURE

GREEN MANURING



GREEN MANURING means turning under suitable crops to enrich the soil. Such crops may be turned under green or when ripe.

Green manuring adds organic matter and, directly or indirectly, nitrogen to the soil.

Leguminous crops are most desirable for green manuring, since they add to the soil nitrogen gathered from the air in addition to the organic matter which they carry.

Besides the nitrogen in the legumes turned under, an additional supply of nitrogen is fixed in the soil by the action of bacteria, using the carbon in the organic matter as a source of energy.

Turning under an entire crop is advised only when the soil is poor and for the purpose of starting a rotation.

Turning under catch crops or winter-grown green crops is an economical and successful method of supplying nitrogen.

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief
Washington, D. C. April, 1922

GREEN MANURING.

By C. V. PIPER, *Agrostologist in Charge*, and A. J. PIETERS, *Agronomist, Clover Investigations, Office of Forage-Crop Investigations.*

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DEFINITION OF "GREEN MANURING."

"GREEN MANURING" means the turning under of green plants for the enrichment of the soil (see title-page). Taken broadly, this would mean the turning under of weeds or the aftermath of a grass or clover crop, as well as a crop especially grown for turning under. Commonly, however, the term is used in a narrower sense and is applied to the turning under of a green crop grown especially for the purpose; or if not grown especially, at least used in that way rather than put to some other possible use, as when the second crop of clover is turned under instead of being cut for hay or for seed. With perhaps minor modification, the same processes are involved and the same results are attained whether the plant material is turned under dry or green.

Cover crops frequently serve also as green-manure crops. However, when a cowpea cover crop is allowed to remain until spring and the dead vines are then worked into the soil, this operation can scarcely be spoken of as green manuring, but is more nearly like turning under crop residues.

"Green manuring," therefore, as used in this bulletin means the turning under of any crop, while green or soon after ripening, for the purpose of soil improvement. While the turning under of crop residues serves to incorporate organic matter with the soil in the same way that green manuring does, economically the practice is very different. In green manuring, crops are turned under that might have been used for other purposes, while crop residues are commonly waste materials.

Green manuring is one of the oldest methods used to maintain or to increase the productivity of the soil. Green-manure crops were employed by the ancients, the Romans using lupines, which were sown in September and turned under in May for the benefit of the following crop. In Germany the use of lupines began in the middle of the nineteenth century and has proved an important factor in reclaiming the sandy lands of parts of Prussia.

In England both legumes and various crucifers are commonly used; in India and Japan the farmers gather green plants of many kinds, sometimes even cutting twigs from the trees and carrying this material to their rice fields; in China green plant material is usually composted and then used, but it is also sometimes turned under in place.

In the United States the use of special green-manure crops is much more general in the South than in the North. In the semiarid regions under dry farming green manures are not used, for reasons that will be made clear later, but under irrigation green manures play an important part in orchard culture in several Western States.

EFFECTS OF GREEN MANURING.

When a green-manure crop is turned under, the various fertilizing elements that have gone into the making of the crop are returned to the soil, and a quantity of organic matter not before in the soil is added. This organic matter serves as food for microorganisms and also improves the physical condition of the soil.

PHYSICAL EFFECTS.

Organic matter affects both the texture and the moisture-holding capacity of soils. Heavy clays are lightened and made more porous and sandy soils are enabled to hold moisture better. For the best growth of the roots of most crop plants both air and moisture are needed. When a stiff soil dries and becomes hard the air is excluded and the roots are likely to suffer not only from lack of moisture but from lack of air.

Clay soil containing organic matter is more friable than simil soil without organic matter. Where soil from which the organic matter had been extracted was allowed to freeze and thaw it remained compact and did not crumble. When the organic matter previously dissolved out of this soil was returned to it the soil crumbled after freezing, the same as the original soil.

Some crop plants, as alsike clover and rice, thrive in a water-soaked soil; and wheat has been successfully matured in sealed pots from which air was excluded. In general, however, experience has amply shown that most crop plants do better when the soil in which they grow is in good tilth. This condition of good tilth is facilitated by organic matter.

Not only do the higher plants grow better in a soil rich in organic matter, but the activities of the soil bacteria are largely dependent on the supply of decaying vegetable matter. These bacteria need food and air. Their food is the dead vegetable matter, which they break down and thus make available to the higher plants. Most beneficial bacteria use air, and this they find more abundantly in a soil supplied with organic matter than in stiff clays poor in organic matter. In sandy soils there is air enough, but the addition of humus helps to hold moisture and so benefits the bacteria as well as the higher plants.

It has been shown that while 100 pounds of sand can hold only 25 pounds of water and 100 pounds of clay 50 pounds, the same weight of humus or decaying organic matter will hold 190 pounds. A good physical condition of the soil, therefore, largely depends on the organic matter in the soil.

CHEMICAL EFFECTS.

The soil in which plants grow must not be thought of as a layer of dead matter in which the plant roots are fastened and from which they draw such substances as they need for growth, but rather as a very busy chemical and biological laboratory.

Besides the elements that plants need, there are many other substances in soils, and changes are constantly going on which make the needed elements more or less soluble. Sometimes these processes develop harmful substances, which in turn may be made inert by other reactions. These interactions would take place to some extent if there were no microscopic plants or animals in the soil, but as a matter of fact every reasonably good soil is full of bacteria, molds, and minute animal forms. These cause changes that affect crop plants, usually beneficially, sometimes harmfully. Of all these organisms, certain species of bacteria are the ones most useful to crops, and these bacteria live, multiply, and work best when there is plenty of organic matter and enough air and moisture. This organic matter may be supplied by stable manure, by crop residues, or by green manures.

Green plants turned under must decay before they can be completely used by the next crop. Decay is brought about mainly by bacteria and fungi, and the process is somewhat complex. Eventually, however, the mineral substances are set free, and it is an important fact that the phosphorus and potassium derived from decayed plants are more readily available for the next crop than are these substances when derived from mineral soil particles.

The proportions of mineral ash materials in crop plants vary, but are in no case large. Since the quantities present in the green-manure crop are only those previously taken from the soil, the turning under of green manures must not be expected to take the place of desirable additions of phosphate, potash, sulphur, or lime. In the decay of plant tissues acids are produced, and these acting on the soil render parts of the mineral foods soluble.

NITROGEN SUPPLY.

One of the most important functions, if not the most important function of organic matter in the soil, is to keep up the nitrogen supply. Fortunately, an inexhaustible supply of nitrogen exists in the atmosphere. The higher plants, however, can not use directly the uncombined nitrogen of the air.

There are three ways in which the available nitrogen in any particular soil may be increased by the aid of microorganisms which, when carbon is supplied, are able to take the nitrogen from the air or to change organic nitrogen to nitrates. It is probable that at least two of these processes are constantly in operation in all soils whenever temperature and moisture conditions permit. The enormous numbers of these microorganisms make possible a very considerable deposit of nitrates. The three processes referred to may be stated as follows:

(1) Growth of the nodule bacteria in the roots of most living leguminous plants.

(2) Ammonification and nitrification of organic nitrogen contained in the soil. This process is performed by different groups of bacteria, and the result is the formation of nitrates which can be used by crop plants.

(3) Growth of free-living nitrogen fixers. Various bacteria and molds living in the soil can take nitrogen direct from the air, provided they have such materials as starch or cellulose for food.

HOW LEGUMES GET NITROGEN FROM THE AIR.

It was known even in ancient times that much larger crops of various kinds could be produced on land that had been in a legume the previous season. In modern agriculture the value of legumes is generally appreciated, as is seen in the common practice of growing clover or some other legume in rotation at frequent intervals.

An examination of the roots of leguminous plants will reveal on many of them nodules, sometimes very few, sometimes many. (Figs. 1 and 2.) These vary in size and shape according to the kind of plant. Thus, on red clover (fig. 2) they are more or less round or ovoid and quite small; on the cowpea they are also round and nearly smooth but much larger; on the velvet bean they may reach the size of a pigeon's egg; on the vetches they are irregular both in shape and size.

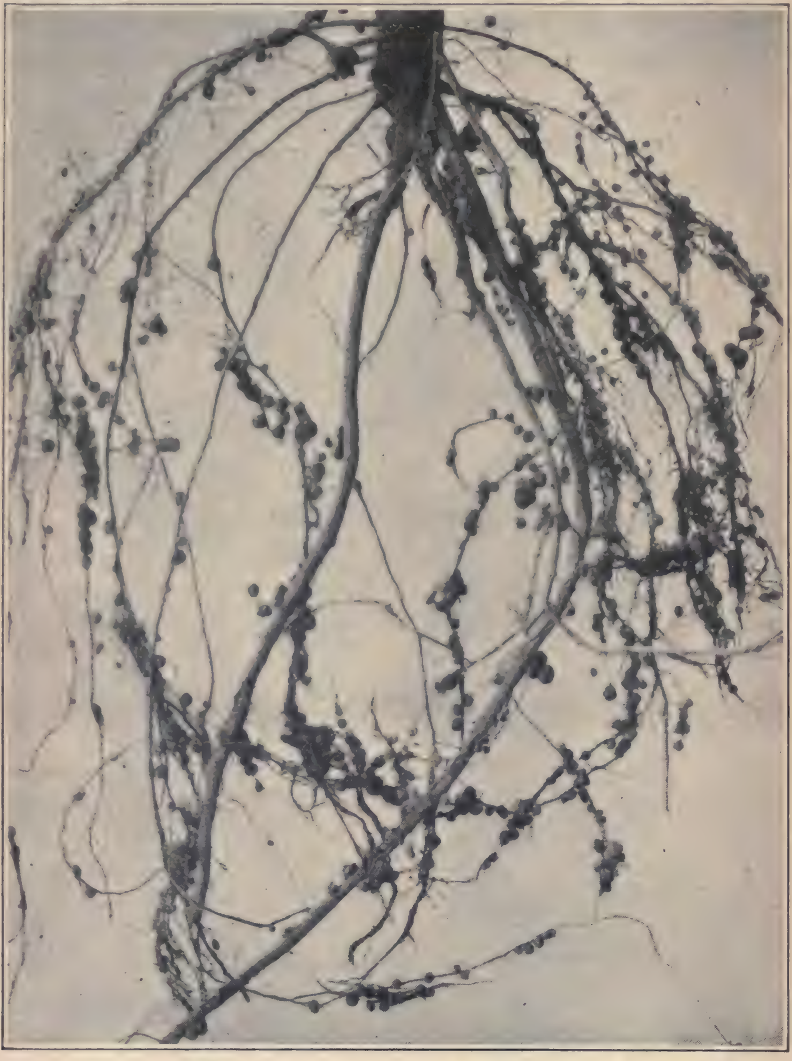

FIG. 1.—Root system of a soy-bean plant, showing the nodules, which are nitrogen gathering laboratories.

The differences in the nodules are such that in many cases it is possible to determine by the nodules the plant to which the root belongs.

When leguminous plants have these nodules on the roots they can make use of the free nitrogen of the air; when they do not have these nodules they are powerless to do this, but must obtain their supply of nitrogen from the soil in the same manner as most other plants. These nodules are caused by a certain kind of bacteria and it is really by these bacteria that the nitrogen of the air is absorbed so that it can be used by the clovers or by other legumes. The bacteria obtain their principal nourishment from the legume, while in turn they provide nitrogen from the air which can be used by the host plant. When legumes are grown in rich soil they can take the nitrogen from the soil and thrive without having nodules on the roots. In poor soils, however, especially in such as have little organic matter, the growth of the legume is much reduced when nodules are not present. (Fig. 3.) In such soils it is always necessary before seeding a legume to make sure that the proper bacteria are present.

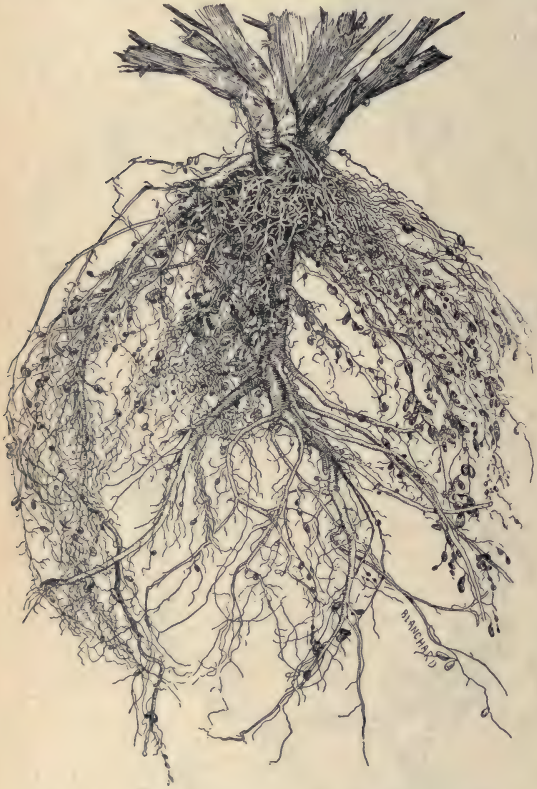

FIG. 2.—Roots of red clover, showing nitrogen-gathering nodules.

SOIL INOCULATION.

Nearly every legume has its own particular strain of nodule bacteria. For example, that of clover is different from that of alfalfa, and that of the cowpea is distinct from that of the soy bean. In planting a leguminous crop for the first time it will often happen that no nodules will form on the roots, because the proper bacteria are not present in the soil. These may be supplied by scattering soil from a field where the crop it is desired to sow has been grown recently or by using an artificial culture of the proper bacteria.

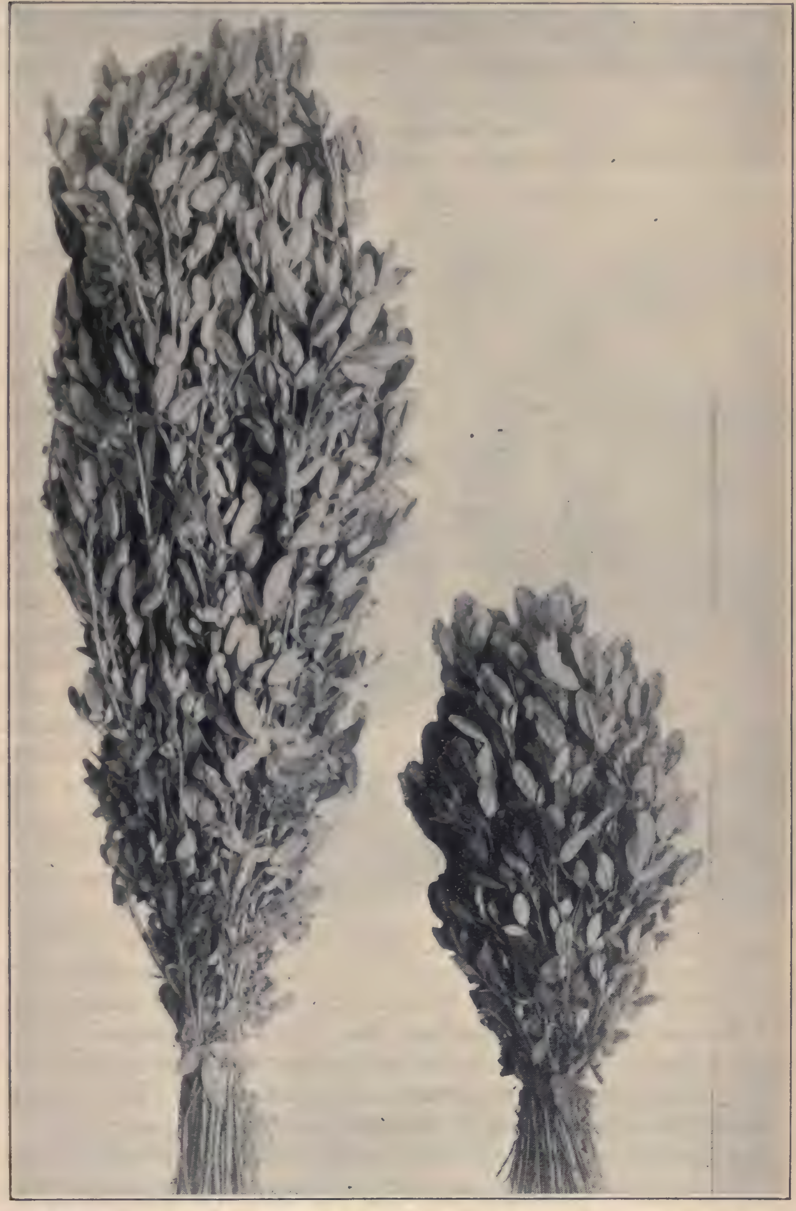

FIG. 3.—Sweet clover grown on poor land. The foliage at the left represents plants that were inoculated, that at the right from adjacent land was not inoculated.

(Fig. 4.) After the field is once thoroughly inoculated there is rarely any difficulty in getting an abundant supply of root nodules.

A strain of bacteria will often inoculate different closely related legumes. Thus alfalfa, bur-clover, and sweet-clover nodules are produced by the same strain; a different strain inoculates most of the vetches, as well as the field and garden peas; still another strain is apparently used in common by red, white, alsike, and crimson clovers.

There is a marked variation among different legumes, both in the extent to which they are naturally noduled and in the ease with which different ones may be artifically inoculated. Natural inoculation presupposes the existence of the proper germs in the soil, and these are nearly always present over areas where a particular legume has been generally grown. Thus, red clover is practically always naturally inoculated in the northeastern and cowpeas in the southeastern quarter of the United States. Alfalfa is naturally inoculated, as a rule, in the West, while in the East artificial inoculation is usually necessary.

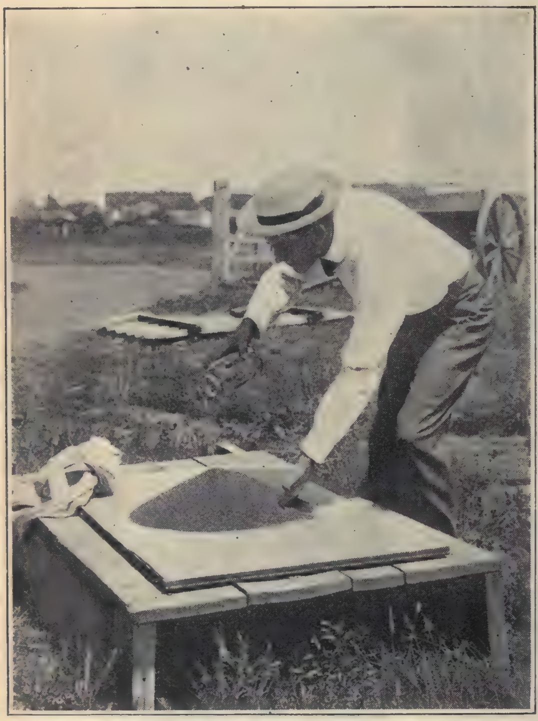

FIG. 4.—Mixing seed with an artificial culture of the proper germs to insure soil inoculation.

Artificial inoculation is usually accomplished with ease as regards cowpeas, the true clovers, vetches, field peas, and most other legumes; soy beans, however, frequently give negative results. Sweet clover is much more readily inoculated than alfalfa, though both use the same strain of bacteria. The presence of nodules is the evidence of successful inoculation; when nodules are not formed inoculation is unsuccessful and no benefit will result.

HOW MUCH NITROGEN DO LEGUMES ADD TO THE SOIL?

Attempts have been made to determine the quantities of nitrogen fixed by the action of the nodule bacteria, but no method has yet been found that will give more than an approximately correct answer.

Analyses have been made of the quantities of nitrogen in various leguminous crops, both tops and roots, but the total nitrogen thus obtained includes some that was taken directly from the soil. Determinations have been made of the total nitrogen in soils before and after growing a leguminous crop, but the result represents merely the net difference between gain and loss resulting from the interplay of a number of factors, and even the net gain can not be safely credited to the legume alone. Lastly, certain legumes have been grown with and without inoculation and the difference in the quantities of nitrogen in the crops determined.

The Michigan Agricultural Experiment Station grew soy beans, inoculating the soil on one field and leaving another uninoculated. Samples taken and analyzed showed that about two-thirds of the total nitrogen was taken from the soil and one-third from the air. The Illinois Agricultural Experiment Station grew alfalfa, both in pots and in field plats, some inoculated, others not. On the inoculated plats the alfalfa in the crops for a season contained nearly 160 pounds more nitrogen per acre than the crop from the uninoculated plats.

At the Central Experimental Farm at Ottawa experiments were conducted with red clover by growing this crop year after year on specially prepared plats of sandy soil with a known nitrogen content. All the clover grown was turned back to the soil during nine years. At the end of this time the soil contained 472 pounds of nitrogen per acre more than at the beginning. As a result of a similar experiment carried on by the New Jersey Agricultural Experiment Station, the conclusion seems warranted that in this case the legumes took from the air and made available to the grain crops at least 54 pounds of nitrogen per acre each year.

The Rhode Island Agricultural Experiment Station found that after growing legumes in pots for five years, removing the aboveground portions of the summer crops but turning under the hairy vetch grown in winter, there was a gain at the rate of a ton of nitrogen per acre, seven-tenths of which was removed in the crops. Many more examples might be given.

On the other hand, workers in Kansas and in Wisconsin concluded that alfalfa took more nitrogen from the soil than from the air and that when the hay was removed there was a loss of nitrogen. In general, however, it has been accepted as an approximation to the truth that legumes get about two-thirds of their nitrogen from the air and one-third from the soil. If these crops are turned under, the soil will be richer in nitrogen; if they are removed, there will be in general little or no change in the nitrogen content of the soil so far as this is influenced by the fixation of nitrogen in the nodules and by the removal of the crop.

AMMONIFICATION AND NITRIFICATION.

When plants are turned into the soil certain microorganisms at once cause them to decay. Decay consists essentially in the breaking down of the complex organic compounds into simpler ones. To change organic nitrogen into nitrates requires the cooperation of three distinct organisms, all living together and all commonly working together so harmoniously that one step follows another without interruption. The first set of organisms breaks down the organic nitrogen compounds into ammonia, and under favorable conditions, as in a manure heap, this process may go on so rapidly that ammonia gas passes into the atmosphere and may be detected by the odor. In the decay of green plant material in the soil, however, the ammonia is used by another organism as fast as it is produced or it is absorbed by the soil. The ammonia, in the form of ammonium carbonate, is used by nitrite-producing organisms to form nitrous acid, from which nitrites are formed; nitrous acid is a poison to higher plants. There is, however, another germ which uses this product so rapidly that it is difficult to find any of the poisonous product in the soil. This last germ changes the nitrites into nitric acid, which, by combining with a base, produces a nitrate. In this form the nitrogen can be utilized by the higher plants.

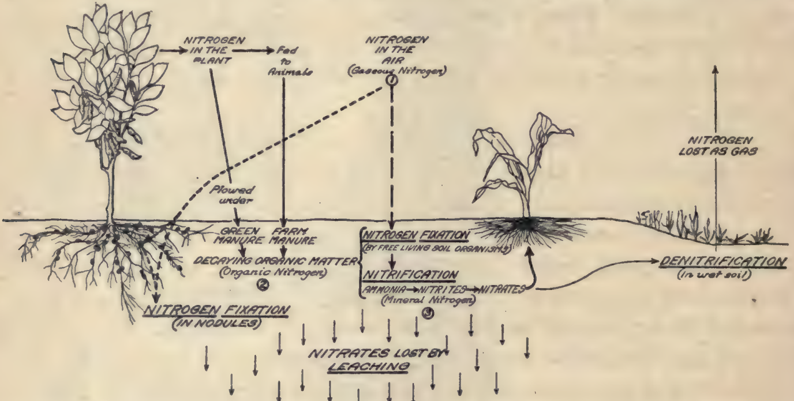
NITROGEN IN THE PLANT
Fed to Animals
NITROGEN IN THE AIR (Gaseous Nitrogen)
①
NITROGEN LOST AS GAS
Plowed under
GREEN MANURE
FARM MANURE
DECAYING ORGANIC MATTER (Organic Nitrogen)
②
NITROGEN FIXATION (BY FREE LIVING SOIL ORGANISMS)
NITRIFICATION
AMMONIA→NITRITES→NITRATES (Mineral Nitrogen)
③
DENITRIFICATION (In wet soil)
NITROGEN FIXATION (IN NODULES)
NITRATES LOST BY LEACHING

FIG. 5.—The nitrogen cycle. The nitrogen that legume bacteria and other nitrogen fixers take from the air is made available to corn through changes that take place in the soil.

Figure 5 shows diagrammatically the processes of the nitrogen cycle. It should be distinctly understood that each change is due to the activity of one or more kinds of bacteria or microorganisms.

NITROGEN-FIXING ORGANISMS.

Besides the nodule germs and the ammonifying and nitrifying germs there are other organisms, bacteria and fungi, living free in the soil which have the power to fix atmospheric nitrogen. The organism of this class most commonly mentioned is called Azotobacter, though this form is but one of several that seem to have the power of fixing in the soil the nitrogen of the air without living in the roots of plants. The organisms of the Azotobacter type thrive in the presence of oxygen, but another type of nitrogen-fixing germ known as Clostridium can fix atmospheric nitrogen only in the absence of oxygen. All of these organisms, however, must have a source of carbon, and the cellulose which makes up the cell walls of plants and whatever starch may be in the plants turned under serve as sources of carbon, so that the growth and activity of these nitrogen-fixing forms is directly dependent upon a liberal supply of organic matter in the soil. How much nitrogen the organisms of this type fix is not known.

The Illinois Agricultural Experiment Station has shown that in the experiments there conducted Azotobacter fixed 15 pounds of nitrogen while using the carbonaceous material in 1,212 pounds of fresh clover tops or in 5,500 pounds of corn stover. Our knowledge of this group is still very imperfect, but it is clear that these organisms using the carbon in organic matter for food play a significant part in maintaining the nitrogen supply of the soil.

RATE OF DECOMPOSITION OF GREEN MANURES.

Very little is known about the exact rate of decomposition of green manures under field conditions, as measured by the production of nitrates. By laboratory experiments it has been found that when legumes are turned under fresh considerable quantities of nitrate may be produced after 2 to 4 weeks. The maximum production seems to take place from 4 to 12 weeks after the green material has been placed in the soil under favorable conditions of temperature and moisture. Dried or cured material is much slower to start and lags behind the fresh material in the production of nitrates as much as 80 to 100 days. In Delaware it was shown that dried plant material when plowed under in spring might remain in the soil practically unchanged until August and so would be of no use to the corn crop for that season. However, in warm, moist, sandy soils even dead plant material if turned under early and well disked and chopped is said to have benefited cantaloupes, tomatoes, sweet potatoes, and even corn. Fresh clover turned under in May has been shown to provide nitrates for the corn crop that year. The rate of decomposition depends, of course, on the character of the soil and the nature of the plants turned under. Legumes decay more rapidly than the grains or grasses. In a loose, warm, moist soil decay will be more rapid than in a cold, stiff, or dry soil.

EFFECT OF LIME ON DECAY AND ON NITRIFICATION.

Lime generally stimulates decay and nitrification. Many laboratory experiments have shown that the production of nitrates goes on most rapidly in well-limed soils. In Pennsylvania, however, it was found that there was abundant nitrification in soils with high lime requirements.

Both the caustic form and carbonate promote the well being of the soil organisms concerned in the decay of plants. Lime in caustic form, however, when applied in large quantities may destroy these bacteria, and it favors the evolution of ammonia to an undue degree. Some experiments have shown that when a green-manure crop is turned under and burnt lime applied there is an actual loss of nitrogen. Lime in the carbonate form is useful, since the bacteria that change ammonia to nitrites can use only ammonium carbonate. When the ammonia is produced, therefore, some form of carbonate must be present from which the ammonium carbonate may be formed or the second step in nitrification can not take place. The carbon dioxid from the decomposition of organic matter probably is an effective agent for the formation of ammonium carbonate. On land that does not need lime for the growing of clover there will be nothing to gain by adding lime when the green-manure crop is turned under. When land needs lime the better practice will be to add this at a time when it will do most good to the legume crop.

LOSS OF NITROGEN.

It is important to know that under certain conditions nitrogen may escape from the soil as a gas. This result is brought about principally by certain organisms, called denitrifying bacteria, that break up nitrogen compounds and permit the nitrogen to escape, usually in the form of gaseous nitrogen. While the details of this process are imperfectly known, it is clear that large losses are likely to occur when abundant decaying matter is present, together with high temperature and lack of air. Such losses occur particularly in rich water-logged lands and in manure heaps. For these reasons it is not good practice to endeavor to obtain a large store of nitrogen in the soil beyond the needs of the crops. For the same reason green-manure crops should not be used on poorly drained lands. According to the English authority E. J. Russell, green manures in swamp and paddy soils in India, China, and Japan serve as sources of oxygen to the rice roots and in this way perform a valuable function. Data as to the value of green manures on rice lands in America are wanting.

Another source of loss is the leaching of nitrates from the soil. Under favorable conditions nitrates are constantly being formed, and since they are readily soluble they are leached out of the soil unless growing plants are present to absorb them. This fact makes it important to consider the time for turning under green crops and for planting cover or other crops to consume the nitrates that are to be produced.

COMPOSITION OF GREEN-MANURE CROPS.

The essential fertilizing substances added to the soil as manures are nitrogen, phosphorus, and potash. Table I gives the proportions of these substances in both the tops and roots of several legumes, as shown by a number of analyses of each.

TABLE I.—*Fertilizing materials in 100 pounds of dry substance.*

[Compiled from various sources.]

Plant and part.	Critical fertilizing substances (pounds).		
	Nitrogen.	Phosphoric acid.	Potash.
Red clover:			
Tops	2.56	0.72	1.40
Do	2.07	.38	2.20
Do	1.97	.56	1.86
Do	2.81	.65	3.10
Roots	2.74	.84	.82
Alfalfa:			
Tops	2.42	.58	1.42
Do	2.30	.53	1.46
Do	2.19	.51	1.68
Roots	2.04	.43	.48
Crimson clover:			
Tops	2.38	1.10	1.56
Do	2.05	,40	1.31
Do	1.95	.36	1.17
Roots	1.50	.47	1.02
Cowpea:			
Tops	2.32	.51	2.92
Do	1.81	.65	1.29
Do	1.59	.30	1.53
Do	1.95	.52	1.47
Do	1.75	.45	1.27
Do	2.23	.57	2.00
Do	2.09	.56	3.04
Cowpea—Cont'd.			
Roots	1.19	0.67	1.94
Do	.68	.64	1.16
Do	1.46	.16	.77
Do	1.40	.73	.76
Soy bean:			
Tops	2.06	.80	1.20
Do	2.32	.67	1.08
Do	2.97	.55	1.98
Do	2.00	.65	2.23
Do	1.53	.57	1.76
Do	2.01	.65	2.17
Do	1.75	.40	1.32
Roots	.81	.36	.90
Do	1.22	.32	.24
Do	1.11	.35	.87
Velvet bean	2.51	.53	3.84
Common vetch:			
Tops	3.53	.74	2.56
Do	3.18	.77	3.50
Do	2.27	62	1.97
Roots	2.19	79	1.18
Rape	3.02	1.26	4.68
Rye hay	1.07	.50	1.70
Timothy	.99	.31	1.36

It has been found that all plants vary widely in the relative quantity of these materials they contain. The same plant varies when grown on different soils or in different seasons on the same soil. In Table I it will be noted that the variation in legumes as regards phosphorus and potash is nearly as great in any one legume as it is between different legumes.

SHOULD GREEN CROPS BE TURNED UNDER, FED, OR SOLD?

The question will be raised whether it is more profitable to turn under a growing crop for green manure, to feed it on the farm, or to sell it as hay. No specific answer can be given, as in every case many local factors will be involved. (Fig. 6.)

Theoretically, there is no doubt that the returns will be greater when crops can be advantageously fed to animals and the manure used on the farm than when the crop in question is turned under, but the theoretically ideal conditions seldom occur. While it is true that mature horses may void nearly or quite all of the fertilizer substances contained in the feed and milk cows 75 to 80 per cent, it is also true that the greater part of this is usually wasted before reaching the land. The maintenance of the organic matter in the soil is an important element in the economy of the farm, but probably not more than 15 to 30 per cent of the organic matter in a hay crop is returned to the soil in the manure. The nitrogen in green-manure crops is also more readily available than that in stable manure. The readiness with which any source of nitrogen supplies this element to plants is called its availability. Lipman rates the availability of the nitrogen from green manure at 65 as against 25 for stable manure. Wheeler rates nitrate of soda at 100, green manure at 70, and stable manure at 45.

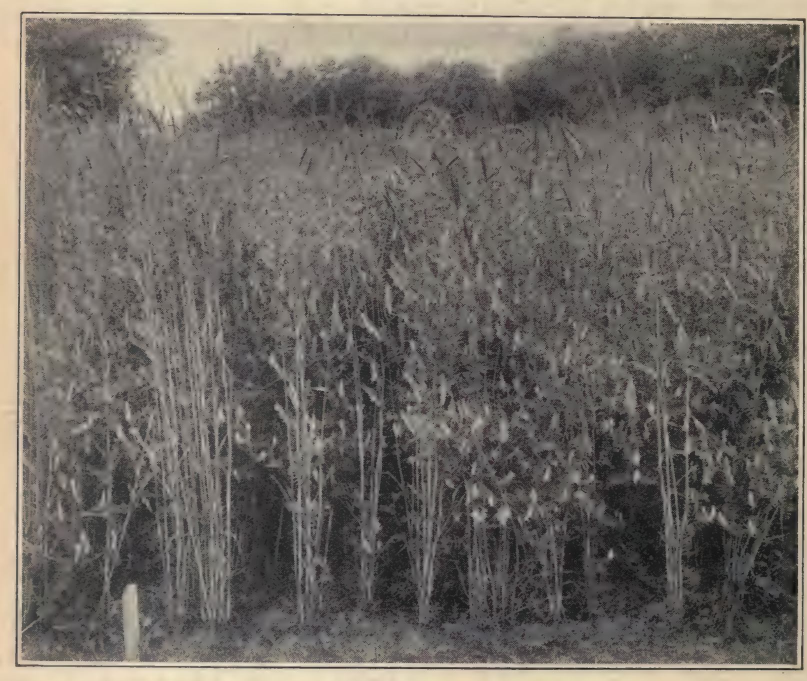

FIG. 6.—Hairy vetch and rye, the best green-manure crop for the North. Is it worth more than hay?

Owing to the wide variations in the quality of stable manure and in the composition and quantity of green manures that may be produced per acre, as well as the cost of commercial fertilizers, a detailed discussion based on hypothetical cases would have little value. It may be suggested, however, that the question of the profits from feeding live stock must rest on the returns from that industry and not on the value of the manure. The benefits from turning under a green crop will certainly be greater than if the manure made from this crop alone is returned to the soil.

The relative values of a crop when sold or when turned under can be expressed somewhat more definitely, though in this case also economic considerations wholly apart from the value of the crop as green manure or as hay will doubtless control. As shown in Table I, plants contain certain quantities of nitrogen, phosphoric acid, and potash. The proportions vary in different crops and even in the same crop, but it is not difficult to determine a general average. According to the average of the figures in Table I, 47 pounds of nitrogen, 11.6 pounds of phosphoric acid, and 42.8 pounds of potash are taken from the farm when a ton of red clover hay is sold. These substances have a market value for which a farmer has to pay if he buys them in commercial fertilizers. The greater part of a green-manure crop, however, consists of organic matter. This organic matter has a value both from its influence on the physical condition of the soil and as a food for microorganisms which will, while consuming it, fix atmospheric nitrogen.

The entire argument may be summed up as follows: Where a forage crop can be grazed or advantageously fed and the manure returned to the land this will be found most profitable. Where insufficient live stock is kept or where the soil is poor and in need of organic matter, a green crop may often be worth more in the long run if turned under than if sold. On the other hand, the Georgia Agricultural Experiment Station in a green-manuring experiment with cowpeas and cotton in 1894 showed that the financial returns for three years were greater where the cowpea vines were made into hay and the stubble turned under for cotton than where the whole crop was turned under. The Georgia station took no account, however, of the increased yield to be expected from the second and even the third crop after turning under an entire legume crop. The Alabama Agricultural Experiment Station and the Central Experimental Farm at Ottawa have shown that such later increases may be expected when the entire legume crop is turned under, but not when the stubble only is used. Whether these increases would pay for the sacrifice of a hay crop in any special case can not be estimated here. The data are too fragmentary for even general conclusions. It is known that the turning under of a green-manure crop may affect the yield of subsequent crops even to the third year, and this fact should have weight when the question of selling a legume hay crop or turning it under is considered.

EFFECT OF A GREEN-MANURE CROP ON THE YIELD OF A SUBSEQUENT CROP.

The value of any particular soil treatment must be determined by the yields of crops resulting from the treatment. In the United States many records show that the turning under of a green-manure crop will increase yields, but none of these tests have been made in such a way as to make possible a definite answer to the questions raised in the preceding section or to throw exact light on the relative value of different green-manure crops. Experimental work on green manuring has been largely confined to the South, the Atlantic seaboard, and to portions of the Pacific coast, with scattering tests in other parts of the United States and in Canada.

In Table II the results of some of the work at the Alabama Agricultural Experiment Station have been brought together as illustrative of what green manuring will do under the conditions prevailing in each experiment. It must be added that there are also records of the failure of green manures to produce increases in the crops that follow them. Such records are most common from the Ohio and Mississippi Valleys and from the West. There is also evidence to show that certain crops are either injured or benefited by a preceding leguminous crop, depending upon the nature of the legume. This will be considered further on pages 27–28.

TABLE II.—*Effect of green manures on crop yields in Alabama.*

Preceding crop.	Yields per acre.		
	Seed cotton.	Corn.	Sorghum.
	Pounds.	*Bushels.*	*Pounds.*
Cotton	837		
	918	18.0	
Cowpea vines turned under	1,533		
Velvet-bean vines turned under	1,373	25.9	
	1,579		13,440
Velvet-bean stubble	1,126		
Oat stubble	342		
Crimson-clover stubble	456		9,750
Crimson clover (ripe) turned under	528		10,300
Corn		13.6	
Ryestubble			5,525

The North Carolina Agricultural Experiment Station grew wheat in 1888–89 and in 1889–1900 on 14 plats, on 7 of which cowpeas had been turned under and on 7 of which there had been no cowpeas. The average yield per acre is shown in Table III.

TABLE III.—*Effect of cowpea vines turned under upon the yields of wheat in North Carolina.*

Crop year.	Yields per acre.			
	With cowpeas.		Without cowpeas.	
	Bushels.	Pounds.	Bushels.	Pounds.
1888–89	25	47	15	54
1899–1900	20	52	6	9

Red clover has been used as a catch crop by the experiment stations in Canada and in Minnesota. The results from some of these trials are given in Table IV.

TABLE IV.—*Yields after turning under a catch crop of red clover in Canada.*

Previous crops.	Yields per acre.		
	Oats.	Fodder corn.	Potatoes.
Wheat:	*Bushels.*	*Tons.*	*Bushels.*
No clover	63.53	16.40	353.33
Clover	72.94	22.80	396.00
Barley:			
No clover	61.18	17.36	346.67
Clover	70.59	23.60	386.33
Oats:			
No clover	58.88	15.00	358.33
Clover	70.59	20.40	392.67

That a legume green-manure crop can replace certain quantities of nitrate of soda has been shown by several experiment stations. Table V gives the result of a trial in California.

TABLE V.—*Results from turning under legumes in California.*

Previous crops.	Yields per acre.		
	Corn.	Potatoes.	Beets.
	Bushels.	*Bushels.*	*Tons.*
On all legume plats (average)	40.00	226	17.9
Barley plats:			
Without nitrate of soda (4 plats averaged)	30.00	161	12.3
With 270 pounds of nitrate of soda	32.00	166	12.5
With 540 pounds of nitrate of soda	42.00	204	15.7
With 810 pounds of nitrate of soda	34.00	191	16.0
With 1,080 pounds of nitrate of soda	41.00	218	17.7

The practice of sowing crimson clover in corn and turning under the clover for the next corn crop is frequently followed on suitable soils from Delaware to the Gulf of Mexico. A case showing the results that may be obtained is reported in Farmers' Bulletin 1121. In this instance the soil was made to produce nearly three times as much corn every year as it had produced once every third year. (Fig. 7.) Under favorable climatic conditions a cultivated crop may be grown every year by seeding crimson clover in the standing crop in late summer and turning it under the following spring for the next crop.

MOISTURE AND A GREEN-MANURE CROP.

A growing crop removes moisture from the soil, and this removal of moisture may reduce yields. In the South it has been found that cowpeas grown with corn often reduce the yield of corn for that year. This is believed to be because the moisture is not sufficient for both the corn and the cowpeas. In the peach section of Michigan a winter cover and green-manure crop is wanted that will make a good growth in late August, so as to draw the moisture away from the trees and force the ripening of the wood. In Nebraska the orchard cover crops recommended are such as are killed by the first frost, others, such as rye, taking too much moisture from the ground in late winter and early spring.

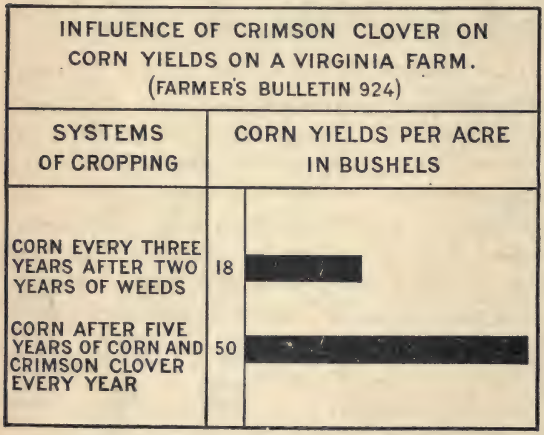

FIG. 7.—Results of growing crimson clover to increase the corn yield on a farm in Virginia.

In the South, East, and North, green-manure crops are commonly turned under at a time when the supply of moisture is ample for decay, but if a dry spell should follow the turning under of a heavy crop of green matter the soil should be well rolled and compacted to prevent drying out. In the semiarid parts of the West and Northwest moisture is the limiting factor in crop production, and any practice that reduces the moisture supply of the main crop is to be avoided. The Office of Dry-Land Agriculture Investigations of the Bureau of Plant Industry has found that green-manure crops which make their growth so as to be turned under late are usually injurious. They not only take up the soil moisture while growing but absorb large quantities when turned under and leave the soil more porous and exposed to drying than before. If, however, a crop like rye can be turned under early, before the close of the rainy season, some benefit may accrue, since the green manure will hold the extra moisture and help prevent the drying of the soil.

EFFECT OF A GREEN-MANURE CROP ON SOIL ACIDITY.

It is often said that the turning under of large masses of green plant material will sour the soil. In northwestern Ohio some good farmers prefer to allow the mammoth or second-crop red clover to become ripe and dry before turning under, claiming that in this condition it does not cause soil acidity. Enough authentic reports are of record to show that the turning under of a heavy green crop may depress the yield of a crop immediately following. It has been suggested that this may be due to a temporary decrease in the supply of available nitrates. Experiments have shown that in the presence of large quantities of food material, such as may be found when masses of succulent plants are turned under, there may be an enormous increase in the numbers of bacteria, especially the putrefactive ones. These may then consume the nitrates as fast as produced and even decrease the available nitrogen in the soil. However, our information on this point is at present limited. The results of experimental work on the acidity produced by green manures are somewhat conflicting, but on the whole they tend to show that green manures do not increase soil acidity or, if so, that such a condition is transitory. When properly turned under there is probably little danger that the quantities of green manure likely to be plowed under on farms in the United States will exert any lasting effect on increasing the lime requirement of soils.

FERTILIZING THE GREEN-MANURE CROP.

The object in growing a green-manure crop is to produce as much material as possible to turn under. On very poor soils it frequently happens that even the strongest feeders can make but a poor growth, and consequently the benefit from the crop is decreased. Even cowpeas will sometimes make only a poor growth unless the plants are stimulated by an artificial fertilizer. When a legume is grown the addition of nitrogen is not usually necessary, as the legume will gather its own nitrogen, but an application of phosphorus and potash often increases the crop greatly and thus enables the plant to gather more nitrogen. The phosphorus and potash that may be applied for the benefit of the green-manure crop is not wasted either, as it will all be available for the next crop when the green-manure crop decays. What fertilizer and how much should be used will depend on the soil and on the crop, but generally 300 to 400 pounds of 16 per cent acid phosphate and 100 pounds of muriate of potash per acre will be found to stimulate the growth of the green manure so as to produce a larger crop than could have been grown without the fertilizer. The larger crop, if a legume, will gather more nitrogen than a small one could, and the soil will receive correspondingly greater benefit. It is also good practice to apply stable manure to specially poor spots, so as to encourage a good growth and thus bring the field up to a more uniform productiveness.

COVER CROPS.

A cover crop may be defined as one grown between or among regular crops and seeded for the purpose of protecting the soil or the roots from the action of the weather. A cover crop is often a green-manure crop, and the term "cover crop" as often used is exactly synonomous with a green-manure crop. Crimson clover, for example, when grown for a winter green-manure crop is also a cover crop, and writers often call it such. Its function in such a case is twofold: It covers and protects the ground and when turned under serves as green manure. Such a crop should be spoken of as a cover crop when its primary purpose is to afford protection, and as a green-manure crop when its primary purpose is soil improvement. As a matter of fact the two ideas can not be sharply separated. A crop of cowpeas grown in summer for turning under that season is a green manure and not a cover crop, though it protects the ground quite as effectively against summer rains as the crimson-clover cover crop protects it against winter rains.

A cover crop may be an orchard cover crop or one for open fields and may or may not be later used as a green-manure crop. The term "orchard cover crop" is easier to define than the general term "cover crop," for the primary idea is to benefit the trees by helping to ripen the wood and by protecting the roots. It is a crop sown among trees after the period of active spring growth has passed and turned under the next season before or about the time active growth begins. An orchard cover crop is designed to benefit the trees and will vary in character not only with the locality but also with the kind of trees in the orchard. In the Eastern States an orchard cover crop is wanted that will check the growth of trees in the fall and ripen the wood, cover the ground during the winter to hold snow, to protect the roots from freezing, to prevent leaching, and on some soils to help dry out the ground in early spring. For the last purpose a live crop is wanted, and if this is later turned under it becomes a green-manure crop. It must be noted, however, that many experienced orchardists in the East consider the drying of the ground in spring by a live cover crop a danger. It is a necessary evil connected with such cover crops as rye and crimson clover and may have serious results if not guarded against. For this reason such a crop must be turned under early; rye should not be allowed to get more than a foot or so high. In many cases a legume is selected for the purpose of adding nitrogen to the soil. Some authorities recommend sowing mixtures of a small grain, hairy vetch or clover, and rape or cowhorn turnips. The rape or turnips will die during the winter, but in spring the grain and the legume can be turned under as a green-manure crop. It has been recorded in New York that clover stimulated the growth of peaches too late and thus made them susceptible to winterkilling. The crops used will need to be selected to meet the purposes for which they are most wanted. In Nebraska an orchard cover crop is never a green-manure crop, since crops that remain alive during winter are not wanted. They dry the ground too much in spring.

In the citrus and walnut orchards of California the growing of cover crops for green manures has come to be a general practice. Discussing the qualities desired in a green-manure crop in this section, McKee (U. S. Department of Agriculture, Bureau of Plant Industry Bulletin 190, p. 11) says:

> A green-manure crop should be a legume wherever possible, in order to obtain the addition of nitrogen to the soil. It is also necessary that a good growth be made, in order to have a large quantity of organic matter to turn under and incorporate with the soil. Along with good growth should be a heavy development of nodules on the roots, as this is believed to indicate great ability to fix atmospheric nitrogen.
>
> The quality of being able to stand trampling with a minimum of injury is very important where the crop will be subject to such injury, as is the case in citrus orchards where the picking of fruit takes place while the green-manure crop is yet growing. Uprightness and nontwining stems are also desirable where an ordinary moldboard plow is depended upon for turning under the crop. However, if a disk plow is used or the crop is worked in with an ordinary disk harrow, this does not make so much difference, and where the growth is not allowed to become too rank little difficulty is experienced in plowing it under.
>
> The texture of the stem should be such as to decompose readily. Practically all crops, however, if turned under at the right stage of growth decay readily. Thus, the question of decomposition is one of turning under the crop at the right time rather than one of selecting a crop that will decay readily.
>
> That the cost of a green manure may not be too great, it is necessary that the price of seed be reasonable as compared with the results to be obtained.

Some years ago common vetch and field peas were the crops most generally used, but to-day the yellow annual melilot, or sour clover, has largely replaced the peas. The sour clover is not wholly satisfactory, but the seed is cheap. The purple vetch will probably become the chief green-manure crop in this section as seed becomes more abundant and cheaper.

The best practice in the East and South at least demands that the ground shall be covered with a growing crop as much of the time as possible. Catch crops and cover crops are used to occupy the ground between main crops. In the South such a crop should, so far as possible, be a legume. Crimson clover, bur clover, or hairy vetch should be planted in the fall to grow during the winter and be turned

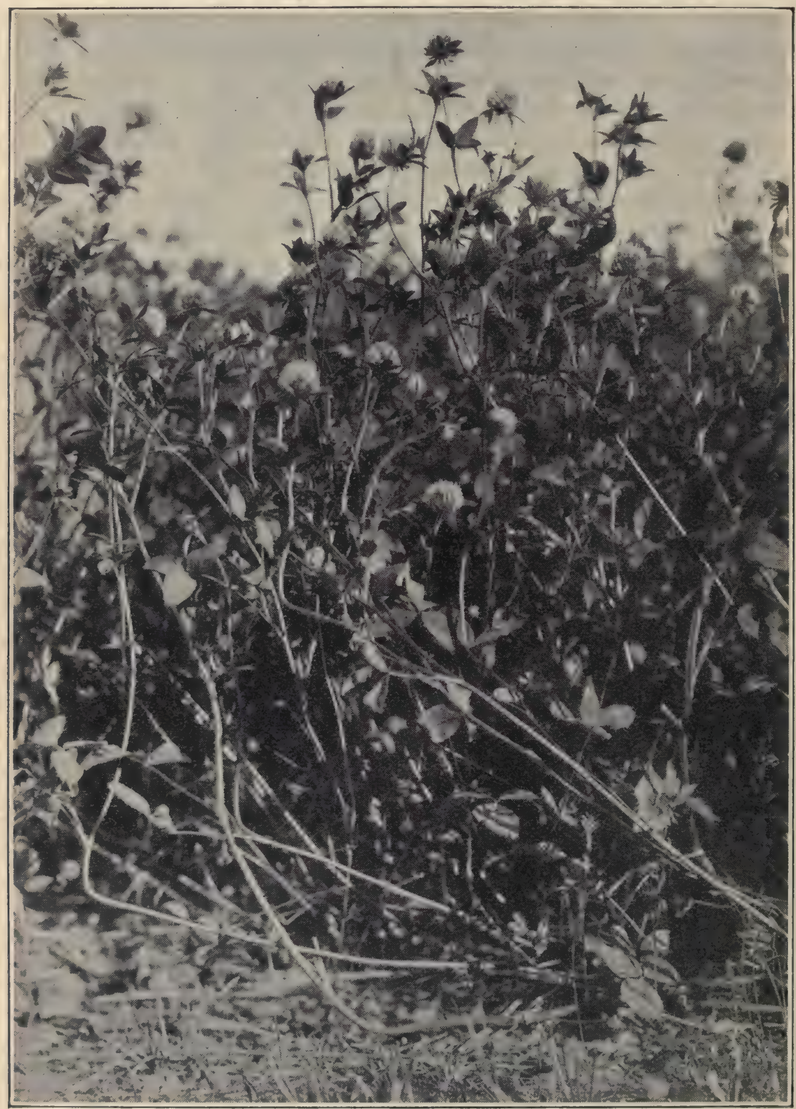

FIG. 8.—Mammoth clover, an excellent green-manure crop. Some farmers prefer to turn this crop under when it is ripe or after the seed is harvested.

under for the benefit of the next crop. In some parts of the South red clover can be used in this way.

In the potato-growing section of New Jersey the practice of growing a cover crop is especially extensive. Writing of the potato industry in New Jersey, Frank App (New Jersey Agricultural Experiment Station Bulletin 295) says:

> The basis and means of maintaining such an intensive industry depend to a large extent on the universal use of cover crops. * * * It is only through this practice that the farmers are able to maintain soil fertility. In many instances the fertility and acre production appear to be increasing rather than decreasing where the cover crops are skillfully handled.

Rye and crimson clover, either separately or in mixture, are most used, although the use of wheat instead of rye is not uncommon. After early potatoes a cover crop may be used or the field may be laid down for hay. After the main crop a cover crop of clover or rye may be seeded, while after the late crop only rye can be used. According to App, cowpeas are sometimes seeded on light sandy land after an early potato crop and are later plowed under and followed by rye. Alsike clover has been used quite successfully in some sections of New Jersey; but both alsike clover and mammoth clover, since they do not start growth so early, must be allowed to stand later in spring than crimson clover. (Fig. 8.)

In the North, outside the Atlantic coast region, hairy vetch is practically the only legume that can be seeded in the fall and make enough growth to turn under in the spring. In Indiana crimson clover is successful only under especially favorable conditions, as on sandy soil, and it can not be generally recommended as a safe crop north of the Ohio River. In Pennsylvania it is reliable only in the extreme southeastern part of the State. Hairy vetch and rye (fig. 6) make a good combination, the latter making a fair growth in the fall and thus preventing the washing of the soil. Buckwheat, rape, and cowhorn turnips are highly recommended in some sections, but they can not serve as cover and green-manure crops to be turned under in spring, as they will not survive the winter. A mixture of half a bushel of seed of wheat or rye, 15 pounds of hairy vetch, and 6 pounds of crimson clover has been successful in New Jersey. A summer cover crop is sometimes used to follow an early crop. In this case such crops as cowpeas, soy beans, buckwheat, rape, turnips, or various combinations may be seeded and turned under for wheat or rye in the fall.

TYPES OF GREEN-MANURE CROPS.

Green-manure crops may be considered as of four types:

(1) Those occupying the ground exclusively throughout the summer. This type of green-manure crop is naturally the most expensive, since no crop can

be removed from the field that season. A green-manure crop of this sort is seldom to be recommended except where very poor soil must be brought to a state of sufficient productivity to allow a regular rotation to be established.

(2) Subsidiary crops, those seeded with a main crop, such as clovers in grain, and turned under in the fall or the following spring. Such crops involve little extra expense besides seed and may even be grazed moderately without serious harm. The Central Experimental Farm in Canada showed that such crops may be very beneficial.

(3) Stubble crops, those seeded on grain stubble after harvest for turning under in the fall or spring. Cowpeas, soy beans, vetch, buckwheat, rape, turnips, and such crops are most commonly used in this way.

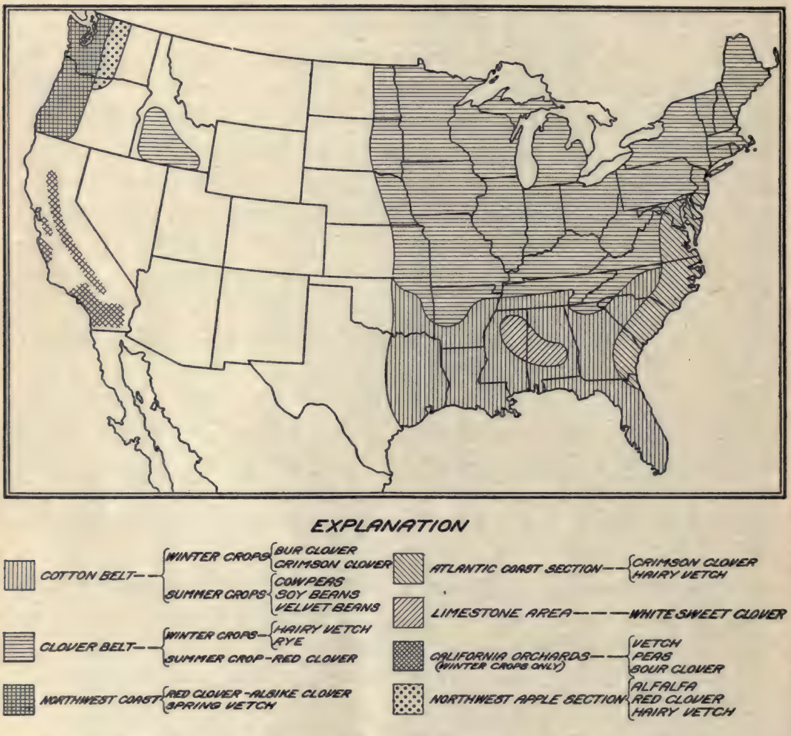

FIG. 9.—Outline map of the United States, showing general green-manure areas.

(4) Winter cover crops. For this purpose crops must be selected that will endure the degree of cold common in the locality. In the South and on the Atlantic seaboard, crimson clover and hairy vetch are most commonly used, but alsike clover and mammoth clover have also been successful in the northern part of this area. Bur clover is a standard winter legume in the cotton belt. Rye and winter oats are also used in the South, especially on soils where it is hard to get a good catch of clover. In the North rye or rye and hairy vetch are most successful.

REGIONAL DISTRIBUTION OF GREEN-MANURE CROPS.

In a general way green-manure crops may be considered with reference to their use in the South, the North, on the Middle Atlantic seaboard, and in the irrigated orchards of California.

In the cotton belt both winter and summer green manures may be used. For the former bur clover, crimson clover, and vetch are well suited; for the latter cowpeas and velvet beans are almost universally used, while beggarweed is locally important, especially in Florida. The benefits from green manuring have been most striking in the South, where yields on run-down lands have been greatly increased by this means. Figure 9 shows approximately the extent of the green-manure sections. It must not be inferred that the crops mentioned are confined to or are the only ones used in the sections named. The map is simply meant to show the sections where these crops are the mainstay in the bettering of yields by green manuring. In the area which is left white, green manuring is not practiced except in an incidental way, as the plowing up of old alfalfa fields.

On the middle Atlantic seaboard, crimson clover is the chief green-manure crop; in the North, red clover and alsike clover, although not often sown especially for green manure, are used in rotations, and the fall and spring growth when turned under adds a considerable quantity of green matter to the soil. Hairy vetch and rye also are used extensively for green manure. In the western part of this area sweet clover has of late years become one of the most important soil-improving crops.

In California green manuring is important only in the irrigated-orchard sections. Here the seed is planted in the fall, and the crop makes its growth during the winter. During the summer the soil is kept cultivated after the green-manure crop is turned under. The crops that have proved best in southern California are all legumes; vetch and field peas were in recent years most commonly used, but the use of the yellow annual melilot and vetch has become more common. In the apple and pear orchards of Oregon and Washington alfalfa is the commonest green-manure crop, but vetch or red and alsike clovers mixed are often used.

CROPS TO FOLLOW GREEN MANURES.

The full results of a green manure are obtained only after it is completely decayed and the mineral elements changed into soluble forms. This requires some time, so that the beneficial results often extend over two or more seasons. When a green crop is turned under in late spring nitrification may go on so rapidly that in 45 days maximum nitrification may be reached.

Generally speaking, cultivated crops are the best to follow green manures. The tillage of such crops hastens the decay of the vegetable matter and by aerating the soil favors additional nitrogen fixation by the soil bacteria. Corn, cotton, and potatoes on most soils derive great benefit when following green manures. Rye and oats are likewise good crops to use in this way. Wheat and barley give varying results, often favorable, but sometimes show no increase, and occasionally a loss is shown. This is especially true the first season following a green-manure crop.

That the proper succession of crops may be a matter of importance has been shown by the Rhode Island Agricultural Experiment Station. According to these studies one crop may have a specific influence on another, making it undesirable as a preceding crop. While these studies have not been carried far enough to enable us to draw conclusions, it seems clear that the proper succession of crops, especially in intensive farming or in the growing of truck crops, should be carefully considered.

At the United States Department of Agriculture Tobacco Experiment Farm it has been found that the growth of tobacco is greatly inferior after soy beans, but that cowpeas, hairy vetch, and red clover are beneficial. Corn is benefited by soy beans. Grass injures tobacco, corn, and potatoes.

WHEN TO USE GREEN MANURES.

Green manuring in some form should be part of the regular farm practice on most of the farms east of the one hundredth meridian and on irrigated land elsewhere. This does not mean that the production of regular crops for sale or consumption should be sacrificed, but that rotation should be so arranged as to work a green-manure crop of some kind between regular crops. Summer green manuring can be recommended only on poor soils, the returns from which must be temporarily sacrificed in order to improve the land, or on sandy, clay, or adobe soils to improve the physical texture. In orchards, too, the summer green-manure crop is profitable, as it does not interfere with the main or fruit crop and is even beneficial to the trees. Attention has been called to the evidence that green-manure crops will increase yields and also to the fact that, so far as any exact observations are of record, it would appear that the value of the increased yields does not usually equal the forage value of the green-manure crop. This fact makes it inadvisable, as a rule, to sacrifice a summer crop for green manure. Green-manuring crops should, however, be grown as catch crops, seeded with or after a grain crop or after potatoes or other crops that can be harvested in time for seeding. If a legume can not be seeded early enough, rye should be used, or a legume like sweet clover on suitable land may be seeded with grain in the spring and turned under for corn the following spring; this practice is very successful in Illinois. The annual white sweet clover may be used and turned under in the fall. Red clover might be used in the same way, but the growth to be turned under will not be as heavy as for sweet clover, and the stand, if obtained, is likely to be more valuable in the regular rotation; in fact, on good soil where the rotation includes clover every third year the need of a green-manure crop will not be so often felt. This is especially true where such land is kept in good shape by the addition of lime or phosphates, where these are needed. By this means the legume crop is stimulated to a better growth, the root development is better, and more stubble and crop residues are left to furnish organic matter. About one-third of the weight of the red-clover plant and about half of that of alfalfa is in the root, so that when these plants or sweet clover are used in the rotation the income from the land need not be sacrificed for the sake of growing a green-manure crop.

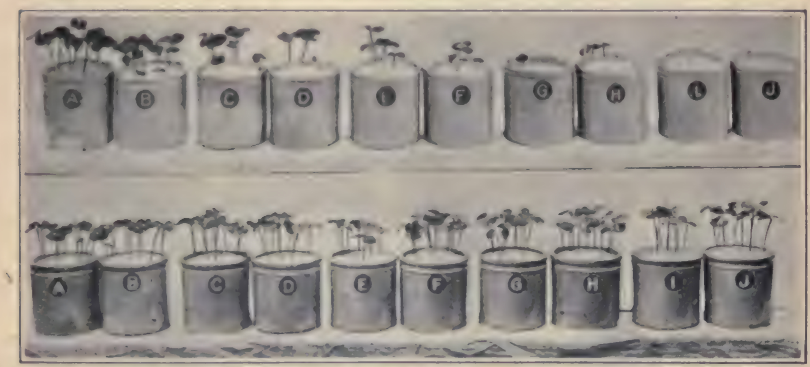

FIG. 10.—Pots of plants, showing the effect of sowing cotton seed immediately after turning under a green-manure crop. In pots C to J of both rows green manure was turned under; seed was placed in the soil of the upper row at once, in the lower row after two weeks.

The use of green manures in dry farming in semiarid regions is as a rule impracticable, as with insufficient moisture vegetable matter decays very slowly. The soil is thus filled with air spaces and loses much water by evaporation.

WHEN AND HOW TO TURN UNDER A GREEN-MANURE CROP.

Though no definite dates can be given for the turning under of a green-manure crop, certain general considerations will govern. To be useful to the next crop a green crop must decay, and for this, moisture is essential. In the process of decay certain substances are produced and it has been found that during the early stages of decay the effects on seed planted too soon after the green crop is turned under may be injurious. Figure 10 shows the effect on the germination of cotton seed when planted as soon as the green manure has become mixed with the soil. Pots A and B had no green manure; C and D had green manure at the rate of about 2,500 pounds per acre; E and F, 5,000 pounds; G and H, 10,000 pounds; and I and J, 20,000 pounds of green manure per acre. The seeds in the upper row of pots were planted at once. Note that where only 5,000 pounds per acre were turned under the germination was reduced, and where 10,000 pounds were used, which is only a small green-manure crop, the stand was nearly a failure. In the lower row of pots the treatments were the same as in those of the upper row, but the seed was planted two weeks after the green manure was turned under.

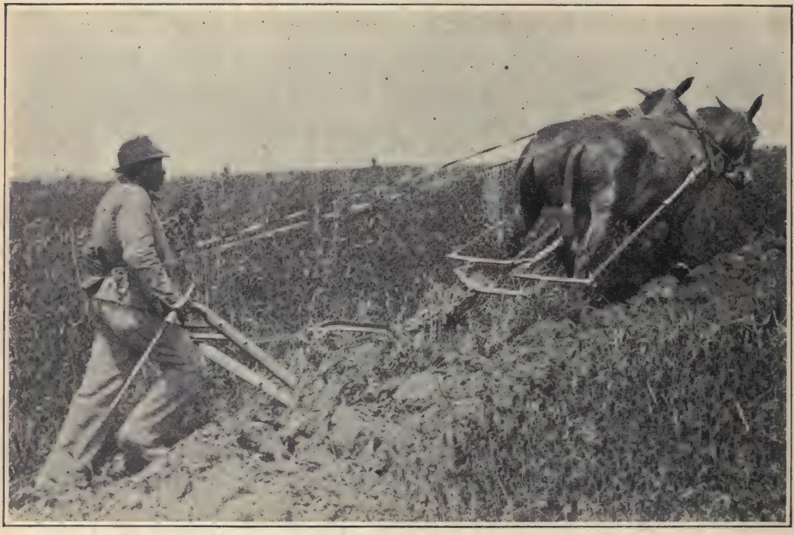

FIG. 11.—Plowing under a crop of crimson clover. This crop should have been turned under at least two weeks earlier for the best results with cotton. (See also fig. 10.)

A green-manure crop, therefore, should be turned under at least two weeks before the next crop is planted. This depends, of course, on the quantity of green stuff plowed under and on the crop to follow; cotton seedlings, for example, are more sensitive to injurious substances than corn seedlings. (Fig. 11.)

Although the time when a given crop must be plowed under may depend largely on other considerations than the maturity of the green-manure crop, the fact that such a crop may increase greatly in value during the later stages of growth should not be overlooked. The Delaware Agricultural Experiment Station showed that the gain in nitrogen made by a crop of crimson clover during the month before full bloom depended on the thickness of the stand and the richness of the soil in nitrates. The plants of a thin stand on poor soil acquired the larger part of their nitrogen during this month and should therefore be allowed to stand as long as possible, while those of a thick stand, especially on soil that had frequently grown clover and was consequently well supplied with nitrates, increased little in nitrogen during this time and might as well have been turned under early. In orchard work in Delaware, Maryland, and adjacent States, crimson clover will necessarily have to be turned under before the maximum quantity of nitrogen has been gathered. If left after the flower buds appear it takes moisture from the soil and trees, so that the land becomes unnecessarily expensive to plow, and decay processes are also pushed too far forward in the season for maximum twig and fruit growth.

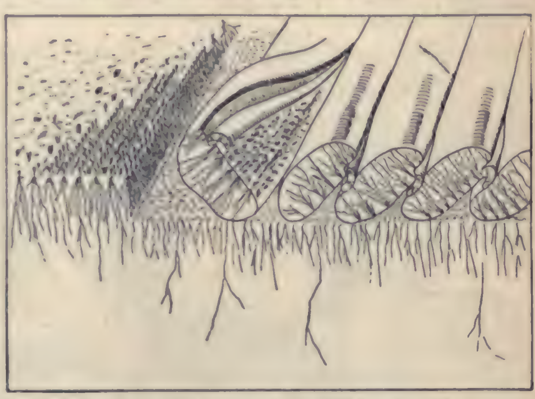

FIG. 12.—Section of plowed land, showing the correct proportions and position of the furrow slice as left by a moldboard plow. The effect of the jointer in turning under the edge of the furrow slice as well as the position of turned-under vegetation is apparent. Do not turn the furrow slice flat; leave it on edge. (From Lyon and Fippin.)

The effect which the time of turning under a green crop may have on the loss of nitrogen should be considered. When a green crop is turned under in the fall for corn the following year there may be some loss of nitrogen in the late spring before corn is planted. However, labor considerations also will help to govern this matter. In some parts of the corn belt farmers prefer to plow in the fall, because the land is cold and wet in the spring and fall plowing enables them to reduce the rush of spring work and to get the land ready earlier. On light land, plowing under a green crop in the spring generally gives the best results, while on heavy land fall plowing is often best. In the South the best rule is to turn under the green crop two weeks or a month before the next crop is to be planted. If the land washes and a winter crop can not be planted, it is better to leave the green crop on the ground than to leave the ground bare.

The turning under of this green matter also interrupts the capillarity of the soil, especially if the furrow slice is laid flat. In plowing, therefore, the furrow slice should be laid slanting; an angle of 30° to 40° is recommended. (Fig. 12.) The soil should also be thoroughly rolled, so as to compact it about the mass of plant matter as much as possible. This will hasten decay and prevent the drying out of the soil. The compacting may be done best with a disk harrow, which will at the same time cut up the surface and prepare the seed bed. A corrugated roller is also an excellent tool. (Fig. 13.)

When the green crop is heavy it may be cut up by disking twice, the second time at right angles to the first, before plowing. A difficulty that may be encountered, however, is the piling up of the loose material in front of the plow. Some farmers have found it a good plan to run a planker over the green-manure crop, so as to lay it flat in the direction the plow is to be run. A chain or a No. 9 wire may also be attached to the back of the plow beam and to one end of the whiffletree, so as to turn the mass into the furrow.

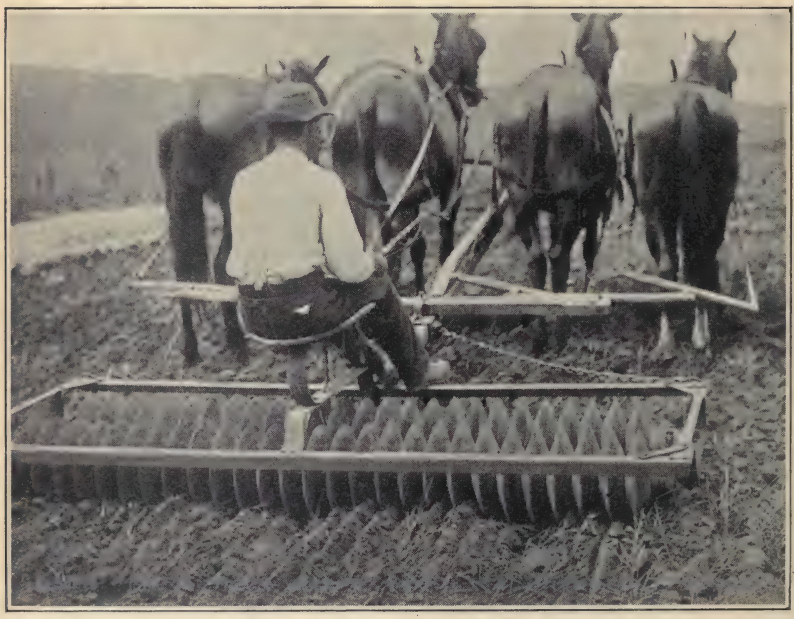

FIG. 13.—Packing the ground after turning under a green-manure crop.

THE CHOICE OF A GREEN-MANURE CROP.

Whenever a green-manure crop is to be used, preference should be given to a legume if it is available, because such a crop will add materially to the nitrogen content of the soil. Where there is a choice between two or more legumes the question arises as to which is to be preferred. Among the important points that determine the value of a leguminous crop are (1) its value as forage, both in quantity and quality either as hay or pasture, and (2) its ability to supply additional nitrogen. Other points that deserve consideration are the cost of the seed, the ease of plowing under the crop, the deep-rootedness of the plants, and their ability to choke out weeds.

When the whole crop is plowed under, the effect on the subsequent crops is determined mainly by three factors—namely, the quantity of humus formed, which is directly measured by the tonnage of the crop, the physical changes brought about in the soil, and the quantity of nitrogen taken from the air and added to the soil. Some authorities contend that the value of a green-manure crop depends almost wholly on the quantities of plant foods, especially nitrogen, that will be liberated by the decay of the plants. There are many data, however, which, though but little understood at present, seem to show that other factors play an important part. These little-known factors appear to be connected with the production of humus and the chemical changes associated with this process. That the production of nitrate is one very important result of green manuring is certain, and it is equally true that legumes will increase the nitrate content of soils more rapidly than will nonlegumes. The effect of various legumes depends, however, not wholly on the nitrogen content, but is in an unknown way specific, as has been pointed out. Much is still to be learned, and so far the value of different green manures has been determined wholly or mainly by the influence they have on the succeeding crop or crops.

Green manures are of value in checking certain chlorotic diseases in orchards, and they are said to influence the quality of the fruit. How these effects are produced we do not know. In India the turning under of green manures just before planting the field to indigo is said to have made the plants more susceptible to insect attacks. From a practical standpoint, we know that green manures are generally beneficial, but we know very little about the processes through which this influence is exerted.

THE PRINCIPAL LEGUMINOUS GREEN-MANURE CROPS.

There are in the United States 14 leguminous field crops that are more or less extensively grown. In the approximate order of their importance these are: Red clover, alfalfa, alsike clover, sweet clover, cowpeas, peanuts, soy beans, velvet beans, crimson clover, field peas, vetch, Japan clover, bur clover, and white clover. A few more, such as beggarweed, grass peas, fenugreek, and horse beans, are cultivated to a less extent or in restricted localities. Many others are being tested or have been tested in an experimental way, but as yet are not grown as crops.

From an agricultural point of view, legumes may be classified into three groups: (1) Summer annuals, including cowpeas, soy beans, peanuts, beans, velvet beans, and in the North common vetch and field peas; (2) winter annuals, comprising crimson clover, bur clover, hairy vetch, common vetch, and in mild climates field peas (in parts of the South red clover also behaves as a winter annual); and (3) biennials or perennials, embracing red clover, white clover, alsike clover, alfalfa, and sweet clover.

Each of these crops can be grown advantageously only in a more or less definitely limited region. For the particular purpose in view it rarely happens that a choice of two or more equally valuable legumes is offered. Usually one is so much superior to any other available legume that substitution is practically out of the question. In a few cases, however, the use of one legume in place of another is practicable. Thus, cowpeas and soy beans are agriculturally much alike and are adapted to nearly the same regions.

In like manner crimson clover, bur clover, and the vetches over a large area may be used one in place of another. In some sections the culture of red clover is no longer profitable, and alsike clover or sweet clover is being substituted. Alsike clover commonly yields less but will grow on soils deficient in lime. Sweet clover is even more dependent on the presence of lime in the soil than red clover, but when lime is supplied it will grow on poorer soil and resist more hardship than any similar crop. Being a biennial it can replace red clover in a rotation. It is one of the best soil-improving crops known. There is also an increasing use of alfalfa in place of red clover, but with alfalfa the best practice is to keep the fields in this crop three years or longer.

RED CLOVER.[1]

Red clover (fig. 8) is a biennial and the standard legume in farm rotations in the Northern States. It is commonly seeded with grain, cut for hay once and for seed if the conditions are right, and the aftermath pastured or turned under for the following crop. A very large proportion of the red clover seeded is put in with timothy. Mammoth clover, a large-growing form of red clover, is much used for soil improvement, as it makes a greater mass of growth than the medium red. Red clover is not infrequently seeded in wheat and either that fall or the following spring is turned under as a green manure for the next crop. At the Central Experimental Farm of Canada it was shown that the winterkilling of red clover did not destroy its fertilizing value. With the exception of its use as a catch crop the entire growth of red clover is probably seldom turned under for green manure, as it is too valuable for forage or for seed. The roots and stubble, however, contain much more fertilizing matter than is the case with most legumes. The roots of red clover extend to a depth of 4 to 6 feet, but much the largest portion is in the upper foot of soil. The proportion of root to top has been variously estimated. The Minnesota and Delaware Agricultural Experiment Stations found nearly half as many pounds of root as of top; the Wisconsin station one-quarter as much; the Central Experimental Farm at Ottawa more than two-thirds as much; while in 1-year-old clover in Michigan the weight of roots nearly equaled that of tops.

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[1] *Trifolium pratense.* Consult Farmers' Bulletin 455, entitled "Red Clover."

The percentage of the total fertilizer ingredients in the crop that is found in stubble and roots is also larger in red clover than in any other legume except alfalfa, though figures on sweet clover are not available. The Delaware Agricultural Experiment Station found that 30 per cent of the money value of the fertilizers in the crop was in the root. Red clover, therefore, is better suited than most legumes to a place in the rotation which requires the removal of the parts above ground and the use of the stubble and roots for keeping up the subsequent yields. However, it must not be thought that such a system can be continued indefinitely, except possibly on very rich soil. It has been found that on many soils turning under roots and stubble only once in three years is not enough to maintain yields.

CRIMSON CLOVER.[2]

Crimson clover (figs. 7 and 11) is a winter annual and is an important crop along the Atlantic coast from New Jersey southward and in many parts of the cotton belt. On the Atlantic seaboard and in portions of the South it is the great winter cover and green-manure crop. While the root system is extensive, it does not compare favorably in this respect with red clover, the Delaware Agricultural Experiment Station finding but 10 per cent of the air-dry substance in the root, as against 30 per cent for red clover. However, the percentage of nitrogen in the entire plant is higher in crimson clover than in red clover. From Delaware to the Gulf of Mexico it is frequently seeded at the last working of the corn or cotton and turned under for the next crop. In the South it is necessary to turn it under before it has attained full development if it is to be followed by cotton, but if corn is to be planted the clover may be allowed to come into bloom, or a seed crop may even be taken and the stubble and straw turned under in time to plant late quick-maturing corn. In

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[2] *Trifolium incarnatum.* Consult Farmers' Bulletin 1142, entitled "Growing Crimson Clover."

Delaware, where crimson clover is very largely used as a winter cover crop, it is thought that it should be plowed under at the first appearance of the blossoms, though some prefer to plow even earlier.

SWEET CLOVER.[3]

Sweet clover is a biennial and has but recently come into prominence as a forage crop and soil builder. In appearance, the plants when about half grown resemble alfalfa, though the leaves are larger and the plant has a bitter taste. When allowed to mature naturally, sweet clover makes a loose bushy plant, 5 feet or more high, with small white flowers in slender racemes. An important characteristic of this plant is the very large taproot, which is powerful enough to penetrate stiff clay soils and in which a great quantity of reserve food is stored up during the first season's growth. Yields as high as 30 tons of green fodder to the acre have been recorded, but there is yet no adequate record of the relation between roots and tops. The composition of sweet clover is nearly the same as alfalfa, showing that turning under a good stand of this crop would furnish a large quantity of fertilizer for the succeeding crop. Sweet clover is perhaps the most important green-manure crop in parts of Mississippi and Alabama. It also is used for this purpose in parts of Kentucky, Illinois, Iowa, eastern Kansas, and western Ohio.

Sweet clover will thrive on almost any soil provided it has plenty of lime. In this respect it has a wider range of usefulness than either red clover or alfalfa, doing well on soils too poor to produce a crop of either of these two plants. It thrives in all parts of the United States. North Dakota is not too cold nor is Alabama too hot, and it will get along with less water and more salt in the soil than any other cultivated legume. Both hulled and unhulled seed is used, and the hulled seed is often scarified. The use of the scarified seed is recommended, especially when prompt germination is wanted.

The seed bed for sweet clover needs to be very firm, and good stands have been obtained by seeding on land so hard that the drill would barely leave a mark. On land that has never grown sweet clover the seed should be inoculated. When grown in the South, soil on which bur clover has grown may be used for inoculation, as the same organism inhabits the nodules on the roots of sweet clover, alfalfa, and bur clover.

In 1916 an annual variety of *Melilotus alba*[4] was introduced to the public by Prof. H. D. Hughes, of Ames, Iowa. This variety grows rapidly, making a growth variously reported as from 3 to 6 feet in height during one season. It forms no resting buds, and consequently does not live over winter. At present too little is known about the crop to permit a positive statement as to its value in the rotation. Many people are hopeful and some are enthusiastic regarding its future, but no data are at hand covering the various points that will affect the usefulness of this variety, except the fact that it makes its growth in one season and will under most conditions make more growth during the season of seeding than the biennial form.

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[3] *Melilotus alba.* Consult Farmers' Bulletin 797, entitled "Sweet Clover: Growing the Crop."

[4] See U. S. Department of Agriculture Circular 169, entitled "Annual White Sweet Clover and Strains of the Biennial Form."

The principal American crop rotations are built around biennial clover crops. Whether the annual variety will lend itself to good rotations remains to be learned. That the annual variety will prove useful may be confidently anticipated, but how useful as a green manure is a question that can not be answered at present.

YELLOW ANNUAL MELILOT, OR SOUR CLOVER.[5]

In the past few years sour clover has become one of the most extensively used green-manure crops in the citrus and walnut groves of southern California. Its extensive use was brought about by the experimental demonstration of its high fertilizing value together with the fact that the seed was available at a much lower price than the seed of any other legume that could there be used for green-manuring purposes. While the demand for this seed has greatly increased it still can be procured at a comparatively low figure. Most of the sour-clover seed on the market is obtained as a waste product from the grain fields of California and Arizona, where it occurs as a weed.

Sour clover is an annual. The requirements for its best development are about the same as for vetch and field peas, but it will not make as much growth during the average winter months in southern California as the other crops mentioned.

In California the minimum temperature at which it can make growth is higher than for common vetch, purple vetch, field peas, and some other plants, and partly for this reason it does not produce as heavy a growth for turning down early, by the middle of February in southern California for example, as do these other plants.

The fertilizing value of sour clover is high, and if a good growth for turning under at the proper time can be had its use is advisable.

BUR CLOVER.[6]

Without doubt one of the most valuable soil-improving crops for the cotton belt is bur clover. It is a winter annual but will not endure severe cold. In the Cotton States its value lies partly in the fact that it can be handled with a minimum of expense, reseeding itself readily and covering the ground during the winter, thus not only enriching the soil at a time when other crops can not be grown, but preventing washing and leaching. When used as a green-manure crop for the benefit of cotton or corn, rows of bur clover may be left standing at suitable intervals when plowing for the summer crop. The burs ripening on the plants thus left will reseed the field for the next winter's stand of bur clover.

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[5] *Melilotus indica.*

[6] *Medicago rabica* and *M. hispida denticulata.* Consult Farmers' Bulletin 693, entitled "Bur Clover."

There are two species in common cultivation, the Southern, or spotted, and the California, or toothed. Of these the Southern species seems best suited to the cotton belt, as it is a stronger grower and more resistant to cold. The seed of the Southern bur clover is commonly sold in the hull, and since particles of soil usually adhere to this, there is no need to inoculate. The California seed is hulled and does not carry inoculating germs.

ALFALFA.[7]

Alfalfa is grown as a cover and green-manure crop, particularly in the apple orchards of parts of Washington and Oregon and in the orange groves of the Salt River Valley of Arizona and to some extent in the irrigated apple orchards of Utah and Colorado. The use of this crop in orchards has become common only within the past few years, though it has been used by a few citrus growers in Arizona for about 20 years. In the Wenatchee, Wash., district about 75 per cent of the orchard area was planted to alfalfa in 1919.

The method of handling alfalfa in orchards is quite variable, though in all cases it is desirable to turn as much of the crop back into the soil as possible. In the Salt River Valley of Arizona good results have been obtained from orange groves in which the alfalfa was allowed to stand throughout the year, uncut and uncultivated. Cutting the crop at intervals and allowing it to lie without further attention also has proved satisfactory; also disking the crop into the soil. In Washington the crop is perhaps more often cut and disked into the soil, though removing the cut crop as hay is not uncommon. This latter practice, however, is not advised except when the need for immediate cash returns makes it necessary.

Alfalfa can be used successfully in orchards only when an adequate water supply is available. While it may save some water by preventing run-off and evaporation, it also uses a large quantity in its growth. Where an abundance of water is not available the alfalfa may use so much as to deprive the trees of what they need. Orchardists must also bear in mind that if a hay crop is taken the haying and spraying operations should be so managed as not to interfere with one another.

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[7] *Medicago sativa.* Consult Farmers' Bulletin 339, entitled "Alfalfa."

Alfalfa can not be used with equally good success in all orchard areas. Soils that are heavy usually require thorough cultivation and are not suited to a permanent crop. It is perhaps also true that a permanent cover crop can be used to much better advantage in regions having intense summer heat, though the exact relation of soil temperatures to crop production in this connection never has been definitely determined.

VETCHES.[8]

Two vetches in particular are cultivated in the United States, the common vetch,[9] or tares, and the hairy, or Russian,[10] vetch. The former is much used as a winter crop for hay and seed in western Oregon and Washington, being commonly sown alone or with oats or wheat. It is also extensively grown in the citrus orchards of California as a winter green-manure crop. In the Northern States it winterkills.

Hairy vetch is in a general way like common vetch, but decidedly more resistant to cold. It will ordinarily survive the winter in most parts of the United States and in Canada. In fact, it is more resistant to cold than any other annual legume grown. On this account it is particularly valuable in the North. Where the winter temperature is not cool enough to prevent growing, as in California, it has been found that hairy vetch grows much more slowly in cool weather than the common vetch, and the latter is therefore preferred. Hairy vetch, however, grows very rapidly as the weather becomes warm.

Hairy vetch is especially used in Michigan both as an orchard cover crop and for the improvement of sandy land. It has been found more successful on the light lands of western Michigan than any other legume that can be seeded in late summer.

Purple vetch [11] is a new and very promising crop for green manure. It is especially adapted for use in the citrus orchards of the southwestern United States. Under mild winter conditions, such as prevail in that region, it makes more winter growth than either common or hairy vetch. It is less winter hardy than common vetch and can not be grown successfully as a winter annual in regions where the winter temperature falls much lower than 15° F. above zero.

Hairy vetch is objectionable where small grains are used in rotation, as it becomes somewhat weedy in grain fields. Common vetch volunteers to some extent. Except for this, vetches are very valuable crops and deserve much more extensive cultivation.

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[8] Consult Farmers' Bulletin 515, entitled "Vetches."

[9] *Vicia sativa.*

[10] *Vicia villosa.*

[11] *Vicia atropurpurea.*

THE COWPEA.[12]

In the South the cowpea (see title-page) is used more than any other crop as a soil enricher. It is characterized by remarkable ability to grow in poor soils and to cover the ground so densely as to choke out most weeds. It usually bears on its roots an abundance of nodules, whether the soil has been inoculated or not, although in localities where the cowpea has not been grown previously the nodules may be absent. In such cases inoculation becomes necessary, for it is through the nodules on the roots that the beneficial effects of the cowpea are produced.

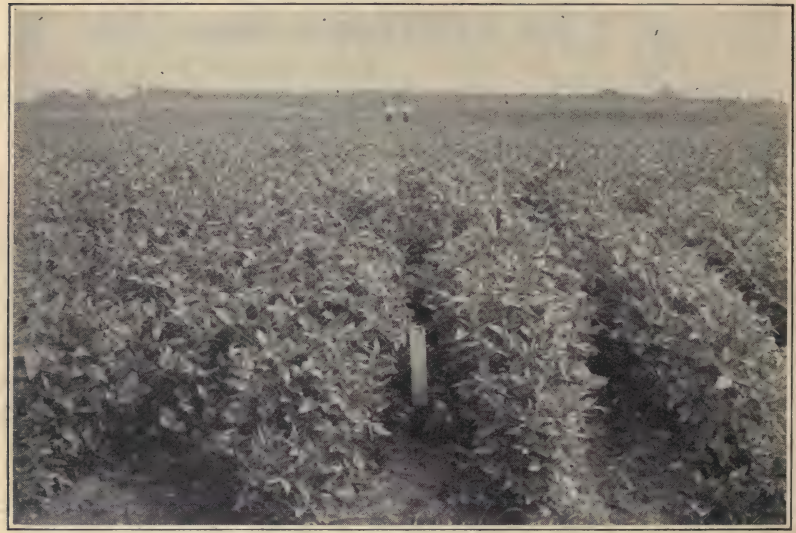

FIG. 14.—Soy beans in cultivated rows, showing the upright habit of the plants.

Cowpeas are commonly planted between rows of corn at the time of the last cultivation, or they are broadcasted upon the stubble of small grains and disked in. Cowpeas, however, like other crops, respond markedly to cultivation, and there is a growing tendency to plant them upon well-prepared soil. This practice results in a great increase of the crop, whether grown for hay or for seed.

More numerous experiments have been conducted in this country to determine the effects of cowpeas used as a green manure than have been devoted to all other leguminous crops combined. Almost without exception these experiments have indicated a very beneficial effect upon subsequent crops. The benefit often lasts two or three years. These good results appear with practically all crops—cotton, corn, sorghum, or small grains. Except on the poorest soils, careful experiments show that it is decidedly more profitable to use the cowpea crop as hay or pasture and then plow under the stubble than it is to plow under the whole crop. Although plowing under the whole crop produces, as a rule, a greater effect, it is not enough greater to equal the value of the crop as feed.

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[12] *Vigna sinensis.* Consult Farmers' Bulletins 1148 and 1153, entitled, respectively, "Cowpeas: Culture and Varieties" and "Cowpeas: Utilization."

SOY BEANS.[13]

Soy beans are adapted to a much wider range of climate than cowpeas, being grown successfully even in Ontario and Wisconsin. As a forage crop, soy beans have some points of superiority over cowpeas, the hay being rich in protein and somewhat easier to cure. The seed is cheaper than that of cowpeas, usually costing only two-thirds as much, principally because of the fact that the seed can be harvested by machinery. It also has the advantage that the seeds are but little affected by weevils and that the plant is not subject to wilt. On these accounts soy beans are preferred by an increasing number of farmers in the South. Soy beans, however, are not able to compete with weeds as successfully as cowpeas, and on this account the best results are obtained by planting in rows so that they may be cultivated (fig. 14). Considerable difficulty is experienced at first in obtaining nodules on the roots of soy beans, but when once these have appeared there is no further trouble with that particular piece of ground. Apparently, soy beans have a greater power than cowpeas to absorb atmospheric nitrogen through their roots (see fig. 1).

VELVET BEAN.[14]

The velvet bean is somewhat objectionable for green manuring on account of the very viny habit of the plant, which renders it difficult to plow under (fig. 15). In orchards velvet beans have been found undesirable on account of their tendency to climb the trees, but the new bush velvet bean overcomes this objection. At the Arkansas Agricultural Experiment Station velvet beans gave better results on a subsequent crop of cotton than either soy beans or cowpeas. With wheat, velvet-bean stubble gave better results than either cowpea stubble or soy-bean stubble, though the difference was very slight. It is noteworthy also that velvet-bean stubble gave much better results on the succeeding crop of wheat than where the whole crop of velvet-bean vines was plowed under, and the same was true in regard to both cowpeas and soy beans. In all cases, however, there was a marked increase of crop, due to the influence of legumes. Velvet beans can not be grown so far North as cowpeas, and not nearly so far as soy beans.

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[13] *Soja max.* Consult Farmers' Bulletin 973, entitled "The Soy Bean: Its Culture and Uses."

[14] *Stizolobium deeringianum.* Consult Farmers' Bulletin 962, entitled "Velvet Beans."

MISCELLANEOUS LEGUMES.

Of less importance than the crops described but yet of considerable use under special conditions is the field pea.[15] This pea was once considerably used in California as a winter green-manure crop in orchards, but it has lately been replaced by other crops. At present, peas are used as a green-manure crop in the orchards about San Antonio, Tex.

The Tangier pea,[16] a native of North Africa, resembles in a general way the garden sweet pea. It has given the largest yields of green matter to the acre of any annual legume grown in California. The dense growth chokes out weeds completely. It is a good green-manure crop, but the seed has been hard to get. There is hope that this difficulty may be overcome.

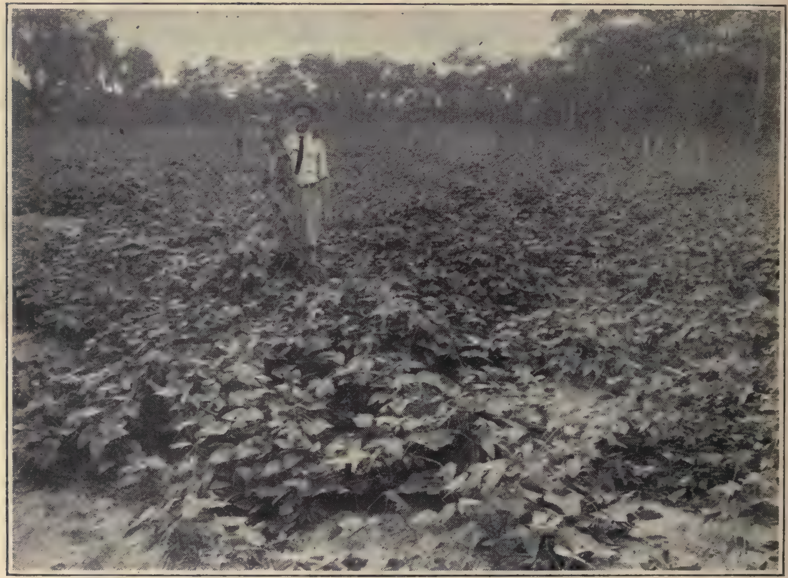

FIG. 15.—A crop of velvet beans 3 months old, showing a great mass of material for soil building.

The upright-growing horse bean produces[17] a great deal of green matter in some sections, but it is not generally equal to vetch. Lupines and yellow trefoil are used very much in Europe but not in America. Fenugreek has done well in California, especially in sections near the coast. Wild hemp[18] is used to a small extent as a green manure on irrigated lands in Arizona and southern California; the partridge pea[19] grows wild on sandy land in the eastern United States and has been used for soil improvement in Maryland. Its use is at present spreading in parts of southeastern New Jersey.

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[15] *Pisum sativum.*

[16] *Lathyrus tingitanus.*

[17] *Vicia faba.*

[18] *Sesbania macrocarpa.*

NONLEGUMINOUS GREEN-MANURE CROPS.

CRUCIFERS.

Cruciferous plants (of the mustard family) are seldom grown in the United States for green manure, though rape is not uncommonly used for hog and sheep pasture. In England, however, both rape[20] and white mustard[21] are frequently used for turning under, and under certain circumstances give better results than a leguminous crop. Reports for a number of years from the Woburn Station showed that yields of wheat were better after green manuring with rape and mustard than after vetches. The soil of the vetch plats, however, contained more moisture, organic matter, and nitrogen than the soil on the rape and mustard plats. In Germany also mustard has been very successfully used as a green manure.

The use of rape and of cowhorn turnips for orchard cover crops has been strongly recommended by some New York and New England authorities. It is possible that on some soils in this country the seeding of rape or turnips on grain stubble to be grazed or turned under for winter grain may prove advantageous.

GRASSES AND OTHER CROPS.

Aside from the turning under of sod, the only grass or grain crops that are used as green manure are small grains, such as rye, wheat, barley, oats, and millet. Of course, any young grain or grass crop could be turned under if circumstances warranted, but as a matter of fact rye and sometimes in the East wheat and barley are about the only grain crops that are used in this way.

Rye is perhaps more commonly used than any other grass or grain as a winter cover and green-manure crop. It is adapted to fall sowing over a wide extent of territory, is extremely hardy, and will make a heavy growth early enough in spring to be turned under for any spring crop. Rye will not add nitrogen to the soil except as the decaying organic matter may furnish carbon as food for the organisms which fix atmospheric nitrogen. It will, however, furnish large quantities of organic matter, absorb a portion of the soil nitrates, and tend to prevent the loss of nitrogen by leaching during winter.

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[19] *Cassia chamaecrista.*

[20] *Brassica napus.*

[21] *Brassica alba.*

In a 6-year test on the availability of different forms of phosphorus the Maryland Agricultural Experiment Station recorded better results from plats on which rye had been used as green manure than on those on which crimson clover had been grown. The prevailing experience has been, however, that where a legume can be grown the results are better than those secured from turning under rye.

Millet is used only as a summer catch crop and is rarely turned under. So far as recorded evidence goes it is not desirable as a green-manure crop.

BUCKWHEAT.

Buckwheat is often grown on poor soil in the North and turned under. It will make some growth on very poor soils, on which clovers would not thrive at all. Buckwheat ranks high in the quantity of fertilizer constituents per 1,000 pounds of green matter, outranking in this respect even alfalfa and clover; but, of course, all the nitrogen in the buckwheat is taken from the stores in the soil, and by turning the crop under the soil becomes richer only in organic matter and in the greater availability of the mineral fertilizers. Buckwheat has long been noted for the excellent effect it has on the texture of the soil. A mixture of buckwheat and peas is said to make a good orchard cover crop in New York. The heavy growth is rolled flat at apple-picking time and makes a desirable floor cover. In the peach orchards of Michigan, on sandy soil, bad results are reported to have followed the use of buckwheat, the leaves of the peach trees turning yellow or reddish yellow and curling. How far this result may be expected on other types of soil is not known, but buckwheat as a cover for peach orchards should be used with caution.

WEEDS.

The so-called "Mexican clover"[22] is not a clover and does not belong to the legume family but to the madder family, to which coffee belongs. It has been introduced into the Gulf coast section from Central America and grows spontaneously as a weed. On sandy land it is used as a green manure and serves the purpose of supplying organic matter, but without directly making the soil richer in nitrogen.

Other weeds also often serve as green-manure plants and are sometimes encouraged to grow for that purpose. Many prominent orchardists do not sow a green-manure crop but allow the weeds to grow in late summer and believe that a heavy crop of weeds makes an effective cover crop. In this case the weeds hardly serve as green manure, however, since they do not survive the winter, and only such dried parts as remain in the spring are turned under. In California various weeds, including alfilaria,[23] or "filaree," bur clover, and various annual grasses, are regularly counted on in the Sacramento and San Joaquin Valleys to make volunteer green-manure crops in deciduous orchards.

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[22] *Richardsonia scabra.*

In the Connecticut tobacco section the growth of chickweed[24] is encouraged in order that it may be turned under for green manure. The soil being well fertilized for the tobacco crop, the chickweed makes a heavy growth in the fall. The lower portions of the plants remain alive, and the crop is allowed to seed before the land is plowed for tobacco the next season. In parts of central Tennessee the wheat farmers encourage the growth of ragweed and smartweed and turn the stand under after the plants have produced seed. It is possible that a better practice might be followed, but the midsummer drought in this section is usually too severe to permit the seeding of any crop after wheat harvest. The weeds in this case do help somewhat in adding organic matter to the soil.

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[23] *Erodium* sp.

[24] *Stellaria media.*

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